Vol. XLIX

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NATIONAL DEEP WATERWAY CONSTRUCTION is the object of a bill introduced in the New York legislature by Senator Lewis, of Rochester, on Feb. 19. The bill provides for a commission which is to consult with the United States government with a view to preparing a plan either for joint construction of a deep waterway or construction by the government of the United States, the plan to be submitted to Congress and to the state legislature before Feb. 1, 1905.

THE UNITED STATES NAVY now consists of 109 vessels "in being" and 44 vessels under construction, according to figures collected by Capt. Sigsbee, Chief Intelligence Officer, U. S. N. From these figures it appears that the "fleet in being" consists of 10 first-class battleships, 112,329 tons; 10 other battleships and coast-defence ironclads, 41,002; 2 armored cruisers, 17,415 tons; 2 first-class protected cruisers of 14,750 tons displacement; 12 second-class protected cruisers, 47,100 tons; 23 unprotected and partially protected cruisers of 32,111 tons; 6 gunboats, 4,020 tons; 12 torpedo-boat destroyers, 5,259 tons; 25 first-class torpedo boats, 3,913 tons; 6 second-class torpedo boats, 285 tons, and 1 submarine of 75 tons displacement. The vessels building are 9 first-class battleships, aggregating 131,200 tons; 2 other battleships and coast-defence vessels of 6,428 tons; 8 armored cruisers, 111,800 tons; 3 first-class protected cruisers of 28,880 tons; 6 second-class protected cruisers, 18,600 tons; 4 destroyers, 1,620 tons; 5 first-class torpedo boats of 1,116 tons, and 7 submarines of 840 tons. We are building no unprotected cruisers, no gunboats and no second-class torpedo boats.

AN ELECTRICALLY-OPERATED DREDGE is about to be installed in the Klondike by the Western Engineering & Construction Co., of San Francisco. The dredge will operate at Atlin, B. C., and will receive its power from an electric plant two miles distant. The electric equipment, furnished by the Westinghouse Electric & Mfg. Co., consists of two 180-KW. belted alternators driven by water wheels, two type F variable-speed induction motors, two type C induction motors for driving the pump, and a 15-HP. motor for operating the screen. The dredge machinery comprises a chain of electrically-driven buckets, a tailings elevator, sluices, etc. It is expected that the first season's run will clean up enough gold to pay for the entire cost of the plant, which, including hydraulic machinery, will be $150,000.

A MEXICAN ELECTRIC TRANSMISSION LINE is to be run on steel towers instead of on wooden poles. The Guanajuato Power & Electric Co.'s line is 105 miles long and will work at 60,000 volts, three-phase. In all high-tension transmission lines the insulators are the weak points, and in this case the number of these weak points is decreased by using long spans of conductor between supports. This requires stronger supports than wooden poles and accordingly steel towers will be used. The permissible length of span is limited by the strength of the insulators if a single insulator is to be used per conductor at each tower; in the present case a span of 440 ft. was adopted. Iron cross-arms and iron insulator pins will be used, and porcelain insulators. The conductors are nineteen-strand copper cable. Mr. R. F. McDoble, of San Francisco, is consulting engineer to the company.

ELECTRICAL POWER DISTRIBUTION in England is reported on by Consul F. W. Mahin, of Nottingham, England. The movement toward establishing large central stations for the "bulk" or wholesale supply of electricity, each system serving an area of some hundreds to over a thousand square miles, began about five years ago, when an application for a franchise for such a company was introduced into Parliament; only in 1901, however, was the first such franchise granted. By the present time some fifteen companies have been authorized, with an aggregate capital of over $40,000,000, of which two are already operating, and several are well along with the construction work. The power supply schemes usually embrace each an entire manufacturing or mining district, and in many cases the generating stations are located directly at coal mines, so that power can be produced very cheaply and this advantage extended to any point within the area of supply. It is expected that in this way the tendency toward concentration of industries in large towns will be checked, and instead an inducement offered to establishing shops and factories in villages.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the Cleveland, Cincinnati, Chicago & St. Louis Ry. near Berea, O., on Feb. 23. A passenger train running west from Cleveland collided head on with an eastbound freight train. The passenger train had waited for the freight a considerable time at a previous siding, and had then gone ahead; the freight was just pulling out of a siding when the passenger train struck it. Both trains were badly wrecked, as the passenger train was running at good speed at the time. Four mail clerks were killed in the collision and in the fire which followed.

AN EXCEPTIONALLY BAD GRADE CROSSING accident in Newark, N. J., on Feb. 19, resulted in the death of ten persons. The Clifton Ave. line of the North Jersey Street Railway Co. crosses the tracks of the Delaware, Lackawanna & Western R. R. at the foot of a steep hill. A street car heavily loaded with passengers was coming down the hill when the gates at the railway crossing were lowered. The motorman applied the brake, but was unable to hold the car; the rails were slippery with ice, the sandbox on the car was empty, and the trackman who should have sanded the tracks had failed to do so. The car slid down hill and broke through the gate and ran out over the tracks; just at that moment a passenger train came along, and the engine struck the front platform of the car. The car was completely wrecked and the engine of the train was badly damaged. Eight passengers of the car were killed outright and two others died within a few days. The street car line in question passes the high school, and the collision occurred just at the time when the students were on their way to school. The car was packed inside and platforms, and it is known that it carried over a hundred passengers at the time of the accident, most of them girls. All but one or two of the victims were girls attending the high school.

TWO DAMS FAILED AT SHELTON, CONN., on Feb. 22, resulting in damage to property below estimated at $50,000. The dams were built by the Shelton Water Co. in 1881. They were on Curtis Brook, about one mile apart. The upper dam formed an impounding reservoir of some 50,000,000 gallons capacity, and was built "of earth, with sheet-piling and clay puddling." The lower dam formed a distributing reservoir, located about a half-mile from and 230 ft. above the village; it was of "stone, grouted, 110 ft. long, 25 ft. high, 4 ft. thick on top, 18 at bottom," with a wing wall 60 ft. long and a spillway in the dam 40 ft. long and 4 ft. deep. The failure of the upper dam is attributed to burrowing muskrats. The lower structure was swept out by the flood from the upper reservoir.

A DYNAMITE EXPLOSION killed two men and mortally injured two others near Rockwood, Pa., Feb. 23. The men were working on the Delaware & Ohio road and had placed 16 sticks of dynamite before a wood fire to thaw. The wood was green and the breaking open of a crackling log is said to have caused jar enough to explode the dynamite. Men were hurled in all directions; the two that were killed being thrown into the Youghiogheny River.

THE EXPLOSION OF AN 8-IN. SHELL at Fort Lafayette, near New York, Feb. 20, killed four civilian workmen and seriously injured five others, one of whom has since died. The 8-in. shell was being emptied of its charge, of canister powder, and it is supposed that grit in the screw thread of the primer necessitated hammering to start the primer, the heat so generated firing the powder.

A PECULIAR CAUSE FOR AN EXPLOSION is alleged in the verdict of a New York state coroner. On Jan. 18, 1903, a digester in a sulphite mill at Dexter, N. Y., blew up, with fatal results. The digester was of steel plate and was lined with brick. The temperature of the digester room was lower than usual on the fatal morning, and when the digester was heated up the brick lining expanded too fast for the steel shell and tore it, so says the coroner.

THE BELLEVILLE BOILER received another setback in a recent competitive run of the British second-class cruisers Hyacinth and Minerva. The Hyacinth was fitted with Belleville boilers, against flue boilers in the other vessel, which in other respects is a sister ship. In a run from Plymouth, England, to Gibraltar, Spain, the Hyacinth ran out of coal twelve hours before the other vessel, and on the return trip, after recoaling, the Hyacinth was forced to stop for boiler repairs soon after starting, while the Minerva completed the run without trouble. It will be recalled that the adoption some years ago of the Belleville, a French water-tube boiler, as the standard of the British navy, called out sharp criticism of the wisdom of the choice. Numerous accidents and breakdowns at sea backed up this criticism. Last year a commission of engineers, appointed for the purpose, reported to the Admiralty on boilers for war vessels, and expressed itself distinctly against the Belleville type, although the water-tube boiler per se was not condemned, and in fact other forms of water-tube boilers were recommended for tentative adoption. It is probable that these competitive steaming trials, for which the two vessels in question were especially fitted up, will definitely settle the matter.

THE COMPETITION FOR PLANS FOR A SEWERAGE system for St. Petersburg, Russia, resulted in the award of but one prize and that a second one of 8,000 roubles ($6,160). This award was was made to Mr. J. Gustaf Richert, C. E., of Stockholm, for a separate system of sewerage. The storm water sewers would be placed above the sanitary sewers and would discharge the first flow of very foul street washings into the sanitary sewers, the main outlet for which would be into the sea. The remainder of the storm water would be discharged into adjacent rivers. Regulating tanks to effect this separation, previously designed by Mr. Richert, were described on p. 361 of our issue of May 8, 1902. There were eleven competitors for the St. Petersburg work, but of the plans submitted five were thrown out as not complying with the terms of the competition. The commission of award, composed of seven professors and seven city deputies, or aldermen, gave Mr. Richert second instead of first prize, because it thought that the sewerage system could not be built within Mr. Richert's estimate of 30,000,000 roubles ($23,100,000). The foregoing is based on a translation made by Mr. Arvid Westerberg from the "Novoe Vremije" of Jan. 17, 1903.

THE DRAINAGE OF THE MEREDOCIA SWAMP, in Illinois, was recently noted in our columns, and we have since received some further information respecting this work. The Meredocia Swamp is a low depression starting from the east bank of the Mississippi River, a short distance below Albany, Ill., and running southeast to the Rock River, about four miles below Erie. At times of high water, especially in the Mississippi River, the floods passed from one river to the other through this depression. A levee has now been built across its upper end, and drains leading towards the Mississippi have been constructed through the upper half of the swamp. At low water in the Mississippi the drainage escapes through the pipes, but when the river rises above the level of these outlets, valves are closed and the drainage water is pumped over the levee into the Mississippi. On the Green River bottoms, between the Rock River and the Green River, a similar arrangement has been established for the protection of a large farm of 2,600 acres, the contractor being Mr. S. W. Allerton, of Chicago. Whenever Green River is high the drainage outlet is closed and the drainage water is pumped over into the river. This has been successful during dry seasons, but last year the river was high during the entire season, and we are informed that the drainage system was insufficient to properly drain the land.

THE NINE-MILE RUN STEEL ARCH BRIDGE AT PITTSBURG, PA.

By Willis Whited, Assoc. M. Am. Soc. C. E.*

The Nine-Mile Run Bridge, or, as it is often called, the Fern Hollow Bridge, crosses the west branch of Nine-Mile Run, on the line of Forbes St. Extension, and is near the southeast corner of Homewood Cemetery. It is one of the most picturesque spots within the city limits of Pittsburg, and I am inclined to think that, in course of time, some of the most beautiful homes in the city will be built in that vicinity.

FIG. 1. STEEL PLATE GIRDER ARCH BRIDGE OVER NINE-MILE RUN, PITTSBURG, PA.

The Monongahela Street Railway Co. had for some time desired to build a line through Wilkinsburg, and parallel to the line of the Pennsylvania R. R., to Turtle Creek, and thence up the valley of that stream. The principal difficulty was to get to Wilkinsburg, as there was no street opened through south of Penn Ave., and that street was occupied by the Consolidated Traction Co. Forbes St. had already been established to the line between the city and Wilkinsburg, but had not been opened all of the way. The street railway company, therefore, made an arrangement with the abutting property-owners and the city, whereby the company was to grade the street and the city was to build the bridge, which is the subject of this article. Early in the spring of 1900, therefore, the author, under the direction of Mr. John Brunner, Superintendent Bureau of Engineering and Construction, Department of Public Works, prepared plans for the bridge.

As will be seen by looking at the map, the Forbes St. route is the shortest from the downtown district to Wilkinsburg, and the region east and southeast of it. The grades are but little, if at all, worse than by Fifth Ave., or by Penn Ave. It is apparently destined to carry a heavy electric railway and vehicle traffic, but the foot traffic will be light for a long time to come. It was, therefore, decided to make the roadway 36 ft. wide, to be paved with asphalt, and to make two sidewalks 6 ft. 6 ins. wide, finished in cement.

CONSIDERATIONS GOVERNING DESIGN.—The opinion is gaining ground among the more progressive city officials of Pittsburg, that the esthetic side of bridge design merits more attention than it has heretofore received, even though it be at a considerably increased cost. This was constantly kept in mind in designing the Nine-Mile Run Bridge. All things considered, the most beautiful and appropriate structure for that place would be a stone viaduct, and some of the neighboring property-owners intimated a willingness to make up at least part of the additional cost if the city would build one; but when a design and estimate were made and a stone structure was found to cost nearly three times as much as a metal structure, the offer was withdrawn. A steel trestle would probably have been the cheapest structure, but it was ruled out for esthetic reasons. Perhaps the next cheapest would have been a deck truss of about 180 ft. span, with viaduct approaches, but that was not considered for the same reason. A cantilever span with the bottom chords arched was proposed, and was found to be somewhat cheaper than the present structure, but that was barred out on account of its excessive deflection, and also because an imitation arch was not considered artistic. It was finally decided that the most appropriate steel structure would be a plate girder arch with viaduct approach. An arch deflects less than any other kind of bridge of the same span, and that is something of a consideration where the floor is paved. A spandrel-braced arch was not considered quite so beautiful as a plate girder arch because its true character as an arch is not so evident, frankness and sincerity being considered essential elements of true art. A braced arch with parallel chords is hardly admissible for spans shorter than about 300 ft. for both artistic and economical reasons. An arch without hinges requires somewhat less material than any other kind, and is also more beautiful, but the greater cost of erection and the difficulty of obtaining sufficiently careful workmanship in erection were the principal reasons why that plan was not adopted; besides, the economy of material is much less important in the case of short spans like the present. The same considerations apply, although with less force, to the two-hinged arch. The three-hinged arch was therefore adopted. Although no attempt was made to conceal the hinges, the flanges were made to present, as nearly as possible, an unbroken appearance from end to end. It was also considered more artistic to make the height from the crown of the arch to the roadway as small as possible, and at the same time have both flanges of the arch show for their entire length, so the highest point of the top flange was placed slightly below the bottom of the fascia girder. The length of span of the arch could vary considerably without materially affecting the cost of the bridge; it was therefore determined to give the arch as restful an appearance as possible without making it look contracted. That condition, it was considered, would be best fulfilled by making the extreme length somewhat less than one-half the total length of the bridge, or 195 ft. c. to c. of pins. It was also found that by doing this, the viaduct spans could be made each 24 ft. and the distance from the viaduct post at one end of the arch to that at the other could be made 204 ft., which is an odd multiple of 12 ft. This arrangement would make the sidewalk brackets all 12 ft. c. to c., with the crown of the arch at the middle of a panel and the panels of railing all of equal length, which adds greatly to the appearance of the bridge, especially as seen from the roadway, which is the principal point of view, as probably ten people see the bridge from the roadway for one who sees it from any other point. This would not be the case with a bridge across one of the rivers in this vicinity.

The roadway is on a grade of 1 in 30, and it was decided to make all vertical members of the bridge normal to the roadway instead of vertical, and the line joining the end pins of the arch parallel to the roadway. This makes the arch symmetrical in every respect, and greatly simplifies the details both in appearance and in construction. If the posts had been made vertical they would have looked as though they leaned toward the high end of the bridge, and the grade of the roadway would have appeared greater than it really was, whereas, as it is built, the grade appears less than it really is, and in the absence of buildings nearby to compare them with, which will probably be the case for a long time to come, few people would notice that the posts were not plumb. The spans at the high end of the bridge are anchored to the abutment which is built extra heavy to resist the stress. The extra cost here is probably more than made up by the saving in the details of the steelwork effected by this construction.

There is no attempt at ornament in any part of the structure except the railing, the idea being that the lines of the structure should be clear and bold, and that its beauty should consist in the symmetry and correct proportions of its parts, with no apparent attempt to conceal anything. The railing, however, is about the only part that is seen by the majority of the people, and is seen at much closer range than any other part of the bridge; it should therefore be more elaborate. As the bridge is pretty high, about 100 ft. form the bottom of the valley, the railing should be substantial, both in appearance and in reality, and so made that children cannot possibly get through it. Furthermore, the hollow under the bridge is wild and picturesque, and any ornament on the lower part of the bridge would be out of place; therefore, the steelwork is perfectly plain and the masonry is all rock-faced. The roadway, on the contrary, is a part of a paved city street which will eventually be lined with fine residences, surrounded by beautiful grounds, and the railing should be made to correspond. The idea was to design a neat and tasteful railing which, at the same time, should not appear out of place on that bridge, and the stone pedestals at each end of the railing are tooth-chisel dressed all over.

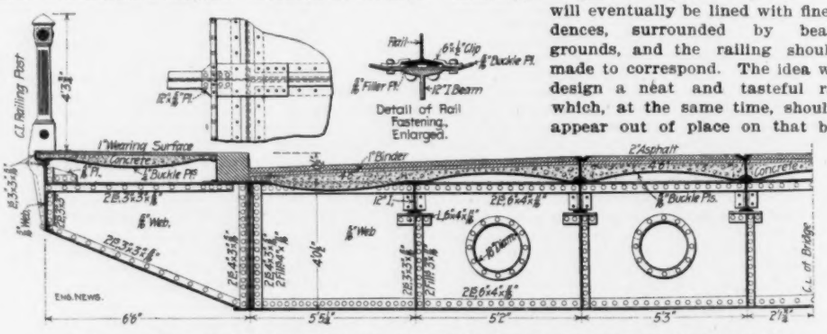

FIG. 2. HALF CROSS-SECTION OF ROADWAY OF PLATE GIRDER ARCH BRIDGE.

One point that was kept in view in designing this structure was to use as few different shapes as possible, in order to avoid any unnecessary delay in obtaining the material from the mills. As it was there was no steel shipped from the mills until about five months after the contract was signed. It is difficult to tell how long it would have been if there had been as many sizes of material as there are in some structures.

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There was little difficulty in obtaining satisfactory foundations for all the masonry, as rock is very close to the surface nearly everywhere. The only difficulty was that common to nearly all sidehill work in this vicinity, viz.: the tendency of the earth to slide downhill, but as soon as the earth and loose rock near the surface were removed excellent foundations were obtained.

All exposed masonry is rock-faced coursed ashlar with rubble backing in the abutments and

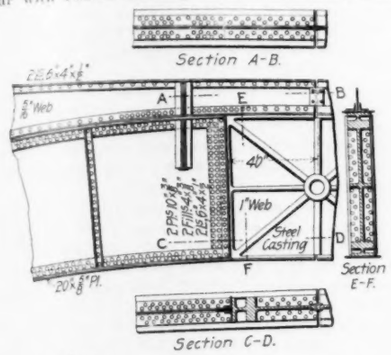


Fig. 3. Details of Center Pin Connection of Plate Girder Arch Rib.

gravel concrete backing in the piers. Considerable sliding of the earth on the slopes was anticipated, so the stonework in the piers was carried at least 3 ft. below the present surface at all points and the piers are high enough to bring the bottom struts at least 3 ft. clear of the ground. Hardly anything is so destructive of steelwork as damp, loose earth. The tops of the small piers are dressed parallel to the roadway so that the bases of the columns are perpendicular to their axes.

solid web bracket at each end of each cross-girder, flush top and bottom at inner end and 18 ins. deep at outer end. The ¼-in. sidewalk buckled plates are carried by an 8-in., 11¼-lb. channel 12 ins. outside of the curb line, and by a fascia girder composed of four 3-in. × 3-in. × 5-16-in. angles and a 27-in. × 5-16-in. web riveted to the outer ends of the brackets. The roadway buckle plates rest directly on the longitudinal and transverse girders, and are also supported by six lines of 12-in., 31.5-lb. I-beam stringers coped into the cross-girders flush on top, and resting on brackets riveted to the webs. The 9-in. Trilby street car rails are directly over the four center lines of stringers. As the paving is pretty deep (9 ins.) between the rails, the 5-16-in. buckle plates are laid with the convex side up, while near the curb, where, owing to the crown of the roadway, the paving would be too thin, the buckle plates are laid with the concave side up. On the sidewalk, owing to the fact that the paving is only 3 ins. thick, the buckle plates are all laid with the concave side up. The sidewalk has a slope of 1 in. in its width. The space between the inner sidewalk stringer and the curb line is filled with a mortar composed of one part Portland cement and two parts sand. This is finished on top and curb side, thus making an excellent cement curb 12 ins. wide and 11 ins. deep. There are four 18-in. diameter holes through the web of each cross-girder for pipes. There is a cast-iron railing post at the end of each sidewalk bracket, carrying a neat and substantial railing, which is well shown in the general view. Fig. 2 is a half cross-section of the bridge, and shows clearly the construction described.

The posts are all made of two 15-in., 33-lb. channels latticed. The two bents nearest the end of the arch are braced together with stiff bracing forming a tower with an expansion joint at each side. The spandrel posts are of the same material and rest directly on top of the arch girders.

ameter pins set half into each. The skewbacks (Figs. 4 and 5) are also steel castings. Where these castings come together, both at the center and at the springing, they are tongued and grooved together with ½-in. clearance so that the flanges of the arch form continuous lines, and there are no visible openings through the webs. The bracing between the arches is all stiff, with latticed struts about 12 ft. to 18 ft. apart, deep enough to connect to both flanges of the arch, with diagonal and longitudinal braces top and

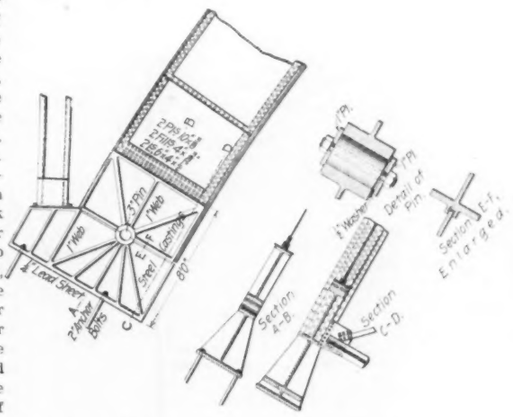


Fig. 4. Details of Skewback Connection of Plate Girder Arch Rib.

bottom consisting of single angles. Near the crown of the arch, where the bottoms of the cross-girders come below the top flange of the arch, they serve as top flanges of the struts, which are made shallower to correspond.

As is mentioned above, the posts of the viaduct are normal to the roadway, which gives them a batter of 1 in 30 toward the low end of the bridge. This produces a longitudinal tension at the high end and compression at the low end. This is resisted at the low end by letting the ends of the girders bear against the backwall and at the high end the abutment is made heavier and two 20-in. I-beams are bedded in the masonry and a 2¼-in. bolt passes through a washer back of them and thence through the masonry, and a sleeve riveted to the bottom flange of the longitudinal girder, and is secured to this sleeve by a nut and washer at the front end.

There is a separate pier for each column and for each skewback of the arch. They are built of dimension stone with at least one course below the surface of the ground, and below that of concrete. The stones in the arch piers are laid with their beds normal to the direction of the pressure. All masonry is carried down to solid rock, which in practically every case was found at quite a convenient depth.

ERECTION OF SUPERSTRUCTURE.—The steelwork was erected without falsework. A traveler was erected at each end, consisting of two longitudinal sills with a heavy double-flanged wheel secured under each end and running upon rails, one line of which was over each main longitudinal girder. To these sills were bolted timbers extending across the bridge, thus making a four-wheel skeleton truck about 36 ft. wide and 30 ft. long. On each front corner of this truck was placed an ordinary stiff-leg derrick with a reach of about 36 ft. A track for an ordinary truck was laid in the middle of the bridge, high enough to clear the cross-timbers of the traveler. Suitable derricks were erected at the ends of the bridge to handle material, and a hoisting engine was placed at each end of the bridge to control all the derricks.

The viaduct approaches were erected in the ordinary way. When the arch was reached the first section was guyed to the last post of the viaduct by two wire ropes connected by two eyebolts and a turnbuckle for accurate adjustment. The remaining sections were supported by steel rods extending back to a suitable anchorage at the end

FIG. 5. VIEW OF SKEWBACK OF PLATE GIRDER ARCH.

DESCRIPTION OF BRIDGE.—The bridge, as built, is shown by Fig. 1, and may be briefly described as follows: It consists of a three-hinged plate-girder arch span, with a viaduct approach at each end consisting of five 24-ft. plate-girder spans; the girders and columns, as well as the arches, being in vertical planes 36 ft. c. to c. The longitudinal girders are 4 ft. deep, riveted into the posts, and the cross-girders are 12-ft. c. to c. riveted alternately to the posts and the centers of the longitudinal girders and flush with them at top and bottom. The sidewalk is carried by a

The arch is 195 ft. c. to c. of pins; 59 ft. rise, and 6 ft. 6 ins. back to back of the 6-in. × 6-in. × ¾-in. flange angles. The single web is ⅝-in. thick, reinforced at the springing. The flange plates are 20 ins. wide. Each half of each arch rib is in four sections with faced joints. The web is fully spliced, although it is extremely doubtful if the web receives as much unit stress as the flanges, owing to its thinness and to the fact that the stiffeners are between 5 ft. and 6 ft. apart. The pin bearings (Fig. 3) are steel castings the full depth of the girder and 4 ft. long, with 8-in. di-

of the bridge. These rods were all joined by turnbuckles, and at one place in each line they were connected by beams so arranged that if difficulty were found in screwing up or unscrewing the rods to adjust the arch segments, the adjustments could be made by means of hydraulic jacks placed between the beams.

Fig. 6 is a general view of the bridge under erection. Fig. 7 is a detail view showing among other things the connection of the anchor rods to the arch rib. Fig. 8 is a view showing the anchor rods at another point, where the turnbuckles were blocked apart, as described above. No difficulty, however, was encountered in making all adjustments by means of the nuts on the rods.

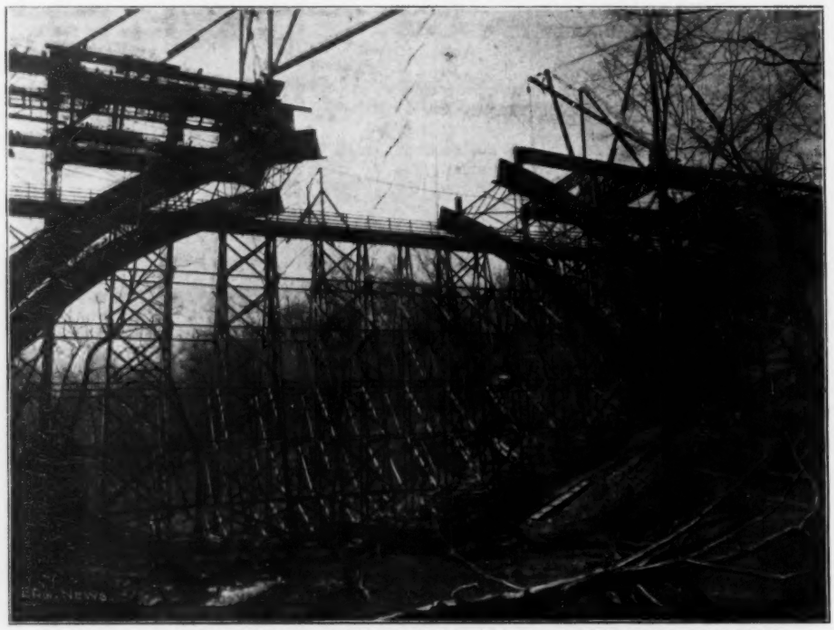


FIG. 6. GENERAL VIEW OF PLATE GIRDER ARCH IN PROCESS OF ERECTION.

The stone used was a good quality of Beaver sandstone, and the concrete was made of Lehigh Portland cement and river gravel. The steel was basic open-hearth steel, made by the Carnegie Steel Co. The steelwork was thoroughly cleaned and painted, one coat with pure red lead mixed with pure raw linseed oil, followed by two coats of pure white lead mixed with pure raw linseed oil, samples from each lot being tested at the municipal laboratory. The roadway paving is rock asphalt laid upon a foundation of Lehigh Portland cement concrete, and the sidewalk paving is of Portland cement mortar laid upon the same foundation.

It was found much more convenient to deliver all the steel at the east end of the bridge, and the part that was intended for the west end was run out to the traveler, lowered into the ravine below, and hoisted up by the traveler at the west end. This was a rather tedious and rough method of handling the steel, but nothing was damaged beyond repair. The whole work was accomplished without an accident to a man except that one of the teamsters hauling steel had his leg broken.

It was hoped that the bridge would be sufficiently advanced to allow cars of the Monongahela Street Railway Co. to cross before Dec. 25, 1900, at which time some of the franchises of the company would lapse if not made use of, but this was found to be out of the question, so the Street Railway Co. built a temporary wooden trestle alongside the bridge for their cars to cross on. This was built almost entirely of timber that could subsequently be used for cross-ties on their road, so that the cost was far less than would appear at first sight.

FIG. 7. VIEW SHOWING CONNECTIONS OF ANCHOR ROD TO PLATE GIRDER ARCH RIB.

FIG. 8. VIEW SHOWING TURN-BUCKLE ARRANGEMENT IN ANCHOR RODS.

CONTRACTORS AND CONTRACT PRICES.—The general contractors for the bridge were the Schultz Bridge & Iron Co., but soon after signing the contract this company sold its works to the American Bridge Co., which assumed the contract. The subcontractors for the masonry and excavation were Keeling & Ridge, of Pittsburg. Owing to the difficulty of obtaining suitable stone promptly, their work was much delayed. The steelwork was manufactured at the Keystone plant of the American Bridge Co., but they also were much delayed by non-arrival of material, which was manufactured by the Carnegie Steel Co. The shop drawings were made by the Pennsylvania Engineering Co., of Pittsburg; the railing was made by the Vilsack-Martin Co., of Pittsburg; the pavements were laid by the Peabody & Filbert Co., of Pittsburg; the painting was done by McNally, of Philadelphia; and the mill, shop and field inspection was done by the Pittsburg Testing Laboratory, Ltd.

The contract price for the bridge complete, as shown on plans, erected in place and painted, was $81,750, and $5.75 per cubic yard for additional concrete in place; $8.75 per cubic yard for additional masonry backed with concrete in place; $9.00 per cubic yard for additional masonry backed with rubble in place, all to include excavation, and 4 cts. per pound for additional steelwork erected in place and painted. The contract price for the inspection was 25 cts. per ton for mill inspection, 25 cts. per ton for shop inspection, and 20 cts. per ton for erection inspection.

The quantities, as per final estimate, were as follows:

Masonry backed with concrete	70 cu. yds.
Masonry backed with rubble	1,340 " "
Concrete	287 " "
Structural steel	1,457,000 lbs.
Railing (889 lin. ft.)	60,000 "
Paving on roadway	1,800 sq. yds.
Paving on sidewalk	5,500 sq. ft.
Curbing	890 lin. ft.

making the total cost of the bridge $85,999.18 for the bridge, and $534.91 for the inspection, or a total of $86,534.09.

The excavations were commenced July 12, 1900; the masonry was commenced Aug. 28, 1900, and completed March 26, 1901; the erection of the steelwork was started March 12, 1901, and finished July 8, 1901; the erection of the railing was started June 20, 1901, and finished June 29, 1901; the painting was commenced June 19, 1901, and finished Sept. 16, 1901.

LOADS AND STRESSES ASSUMED.—The assumed live load was a concentrated load of 8,000 lbs., anywhere on the roadway, and 100 lbs. per sq. ft. on the sidewalk in designing the floor system. The live load assumed in designing the columns was 100 lbs. per sq. ft. over the whole bridge, and a live load of 60 lbs. per sq. ft. over the whole bridge was assumed in designing the arch. The tensile stress allowed for flanges of

plate girders and rolled beams was 12,000 lbs. per sq. in. net section, both flanges of plate girders to be alike. The compression stress allowed for the columns was $16{,}000 - \frac{80\ l}{r}$ lbs. per sq. in. for dead load and $8{,}000 - \frac{40\ l}{r}$ lbs. per sq. in. for live load, in which l = length in inches between supports; and r = least radius of gyration in inches.

The stress allowed in the flanges of the arch was 16,000 lbs. per sq. in. for dead load and 8,000 lbs. per sq. in. for live load. The bearing allowed on masonry was 250 lbs. per sq. in. Medium steel was used for pins and soft steel for all other steelwork. Portland cement was used exclusively.

The intention in preparing the specifications was to make them sufficiently severe to give the city a first-class bridge, and still not so severe that they could not be strictly enforced.

The bridge was designed and the contract let under the direction of Mr. E. M. Bigelow, Director, Department of Public Works, and was built partly under his direction and partly under that of his successor, Mr. Geo. W. Wilson, and under the supervision of Mr. John Brunner, Superintendent, Bureau of Engineering and Construction. Mr. H. B. Rust was Assistant Engineer in charge of substructure, and the author was assistant engineer in charge of superstructure.

MACADAM ROADS AND ROAD SPECIFICATIONS.

By Ernest McCullough.*

The writer has been called upon, from time to time, to prepare specifications for macadamizing streets in several small cities, and a brief review of the methods used in construction follows, together with a record of some of the difficulties encountered in enforcing specifications.

The writer specifies laying rock for macadam in three layers usually.

The first layer is half the thickness of the completed work. The second layer is one-third the thickness of the completed work. The third layer is one-sixth the total thickness. The thickness referred to means the thickness after rolling is completed.

Macadam is said to have made his roads in practically one layer, and to have discouraged the use of binder and of rollers. The stone was cracked by hand, and the size was rather uniform throughout the mass. To-day we have stone broken by crushers and the product is delivered in sizes varying from dust to pieces 4 to 6 ins. through. The product is nearly cubical from some stone, and in long or flat pieces from other stone. It is necessary to provide for using all this material in the streets.

The writer uses the crusher product in the form it comes from the crusher without screening when making a country road. It requires a minimum of sprinkling and rolling, and compacts quickly under traffic. The only separation of sizes is towards the top, when an endeavor is made to have the smaller stuff there. The graduation in size is regulated by the crusher jaws.

But in a city street better work is required. The property can stand the extra expense, and it is well worth a little extra expenditure to get a better roadway. So the maximum size in each layer is one-half the thickness of the layer. For example, if the total completed thickness is to be 12 ins., the lower layer will be 6 ins., and no stones in that layer shall exceed 3 ins. in any dimension; but "no rock dust shall be permitted in this layer, and not to exceed 20% shall be small enough to pass through a ¾-in. screen." This, it will be seen, prevents a too uniform size of stone, and a plentiful supply of smaller rock is between the larger pieces to enable the material to be compacted thoroughly.

When this layer has been spread the roller is passed over it a few times to get it into a reasonably smooth form, when a few wagon loads of rock dust or sand, or both, are taken on the street and deposited lightly on the places where there appears to be an extra proportion of large stone and the roller does not have much effect in compacting it. After this additional binder is put on, the sprinklers start to work, and water is poured on the surface while the roller follows the sprinkler. The total amount of rolling for a 6-in. layer is generally put at one hour for each 300 sq. ft., for each five tons in weight of the roller. It is also specified that sprinkler rollers cannot be used, but that the roller must be of a standard form not less than 50 ins. in width. The contractor must put on a little additional binder in places indicated by the engineer, but care must be taken to use the very least amount of binder which will do the work. It is surprising to see how beneficial water is, and it must be by the lubrication that it does its work. Plenty of water is good.

The second layer on this 1-ft. roadway is composed of stone, placed in a 4-in. layer. The largest pieces will not exceed 2 ins. in any dimension, and not to exceed 20% can be small enough to pass through a ½-in. mesh. No rock dust is used. The roller is passed over a few times to shape it up, then the contractor can add binder of rock dust or sand, or both, or use very fine broken stone. This layer is sprinkled thoroughly, and the sprinkler precedes the roller constantly. For this 4-in. layer the roller will be used one hour for every 200 sq. ft. for each five tons in weight. The binder is added as before in small quantities where it appears to be needed, and will stop the working of the stone.

The final layer of this 12-in. pavement will be 2 ins. in thickness. The largest stone will be 1 in. in the greatest dimension, and the material will range down to rock dust, but not to exceed 20% will pass through a ½-in. screen. This is the layer which makes the trouble. The roller may work the stone until it gets as round and smooth as a marble, or the layer may pack "by first intention," when the heart of the engineer will be glad. The average engineer on his first job strikes his Waterloo on the final layer. The writer confesses that he prefers sand as a filler on the final layer. It is not a binder. He prefers to see the roller go over the street behind the sprinkler, while the contractor sprinkles sand over the loose spots until they cease to be loose and quake. If rock dust is used here, the stuff forms a paste and becomes mud very quickly; but sand is different. It falls into all the spaces and gets as compact as iron. By humoring the top layer, adding sand as it seems to be required, the top layer gets firm; then the final touch is to cover it with a layer about an inch in thickness of sand, or of sand and rock dust, and turn the street over to the city. The rolling on the final completion of the job will be 100 sq. ft. an hour for each five tons in weight of the roller. This gives the top layer three times the rolling that the bottom layer receives.

The writer thinks the sand saves the road from ravelling better than a binder would. When wet weather comes, mud is brought onto the street by the tires of wagons. If the sand is pretty well over the street, it adheres to this mud and dries it to such an extent that it is partly prevented from dropping on the road; what is dropped, mixes with the sand and helps form a sort of cement coating. When the rains come the water runs off the surface of the roadway into the gutters. If the sand is not there, the top 2 ins. of the roadway is very loose, acting as a sort of reservoir for the surplus water. This being in a loose water-charged condition, gives way readily when the muddy wheels come on it and the rock sticking to the mud is carried away. Many engineers and city fathers have noticed with dismay the big ruts and hollows made in fine-appearang streets when the rainy season sets in. A street which was in dry weather a source of pride and satisfaction is a bugbear in the wet season, and influences elections. Sometimes it gives macadam a permanent backset.

This is a common question,

"What shall I do for binder when the stuff is brought in from outside the town by the railroad, and often gets here so late that the contractor has polished the stones in the layer he is rolling?"

Use your common sense. When the roller has compacted the roadway fairly, and it does not move freely, but still shows some movement, the specification says that binder is to be added until the loose places cease to move. If the binder is not at hand, proceed with the laying of the second layer, using it as a binder, but do not place it to its full thickness at once. Place it on the lower layer little by little in the places where it will do the most good, and when the desired result is obtained, bring it then to its proper thickness. Use the delayed binder to bind it. This means a greater cost to the contractor, but he should be more prompt in getting his materials. But every effort must be made to prevent the rolling proceeding to such an extent that the sharp edges are worn off the rock. It may be necessary to use second layer material to bind the first layer, and use the third layer to bind the second.

The writer prefers a jaw crusher to a gyratory crusher. No reason satisfactory to some men can be given for it. It is probably the same spirit which leads some engineers to extol a particular make of transits and levels. This is an unscientific attitude, to be sure. There are some manifest advantages in the jaw crusher for the man needing a small amount of material; but it is largely a matter of opinion. The jaw crusher seems to give a better cracking action, while the gyratory crusher is more of a crusher. So far as the product and the shape in which it is delivered are concerned, it will be found that the character of the rock largely determines that. Some rock has a tendency to give a large proportion of needle-like pieces, while other rock gives flat saucer-like pieces. The best rock is nearly cubical. The specifications should contain a clause to guard against the "saucer" and the "needle," or the street will be hurt.

The engineers should insist upon the contractor having bin capacity enough. The bin should have capacity to hold as much rock as five teams can carry to the work in six or eight hours. It will really be beneficial to the contractor, for sometimes small bins are filled up and the crusher is stopped until the wagons relieve them; and sometimes a breakdown occurs necessitating a stoppage of a day, when the small bins cannot do anything towards keeping things moving until repairs are made. The writer has never yet seen an attempt to deliver directly from the crusher to the wagons successful. Breakdowns will occur. When work drags from June to December, which should be completed in August, some one is at fault. It will generally be found to be the contractor, who is a great sufferer by his own ignorance, but it is the duty of the engineer to get after him in good style when he sees that the public is going to suffer unduly.

The writer has been called upon the past year to prepare specifications for several small cities for macadamized streets, and the returns have been lately coming in. In one place he supervised the work, but in the others the city engineer or a local engineer had charge. The reports indicate that it is possible to get very different results from the same specifications, albeit nearly all the men employed to supervise the work now put on their letter-heads, "Specialty made of road and street improvements."

The legal clauses bother many attorneys and engineers in the small places. The writer has found no lawyers yet in such towns who could prepare a satisfactory contract, but has to acknowledge his indebtedness to many able men for valuable assistance in criticism of portions of the specifications and contracts prepared. While the thing is new to them, they cannot prepare a good contract, but give them a carefully prepared contract and set of general conditions in specifications for criticism, and it is safe to say the future work of that kind in those towns will be well done. They watch the operation of the work and learn from it.

A few items, however, require special explanation. For example, there is the following clause:

> The inspector on the work is not to be considered in any way a deputy of the engineer in charge. It is his duty to see that the specifications are complied with. All disputes between the inspector and the contractor are to be referred to the engineer, and appeal from the decision of the engineer must be made in writing, by the contractor to the mayor within 24 hours, or he will be deemed to have accepted said opinion. All decisions of the engineer appealed from will be referred to the arbitrators hereinafter referred to.

The arbitrators are mentioned in another clause. They are appointed, one by the contractor, one

*Civil Engineer, Lewiston, Idaho.

by the city, and the third by the other two, the conditions of their appointment being of course generally understood.

But it is the inspector who makes trouble in the small places. An engineer writes: "What shall I do with my inspector? He thinks he is running the show." The language used was more forcible, but it was to the above effect. Inquiry developed that the inspector was a brother-in-law of the Chairman of the Street Committee, and was in reality a sort of watch dog on both contractor and engineer. His head, as well as that of his relative, was swelled by the importance of his position. The advice given was to discharge the inspector and put an honest man in his place. Under the wording of the specifications (which express fully the intent), the inspector did not have to be a man of experience in such work or a man who was required to use any great degree of judgment. He was to be simply a perfectly honest man. He was to report to the engineer every deviation from the specifications after calling the attention of the contractor to the same.

It is difficult to understand why the average man when appointed inspector on such work does "try to run the whole show," but it is a fact. In the case mentioned, however, there was some excuse, for the engineer had never seen a macadam road, and the inspector and the Council knew it. It was considered by all parties at interest, except the engineer, that the inspector was as capable of interpreting the specifications as any man in town. The writer, after his experience with both men, pitied the engineer. He is a good man, and lacked only the experience. It has been given him during the past year in good hard doses, however, and another road expert is in the field. The inspector also has cards out. This particular inspector was fired by the engineer and an honest man substituted.

The city attorney gave an opinion that the engineer was in charge, subject to the control of the Street Committee. So the obnoxious inspector went back. Then the contractors took a hand in the game, for they claimed that the inspector was "holding them up." They said their contract provided that the engineer was to be in sole control, and the inspector was to be appointed by him. They refused to recognize the inspector appointed by the Street Committee. The contractors went broke, and the matter is in the courts. The conclusion to be drawn is that circumstances alter cases, and that common sense is a valuable asset of the engineer when in charge of his first job in any particular line of work.

If asked a second time the question about the inspector, the writer would say: Size up the situation and proceed carefully, if you wish to retain your position. If the inspector blusters very much, pay no attention to it so long as he does not annoy the contractor unduly. If he is "real nasty" sustain him once in awhile, and have the arbitrators called in. One or two experiences with the arbitrators will induce the peace-loving members of the Council to have the inspector attended to.

An engineer writes:

The specifications say that the contractor is liable for all damages suffered by anyone, etc.; but another clause says that the contractor must place barricades around all uncompleted work deemed unsafe by the engineer or street commissioner, and place lights, etc. This, our attorney says, placed the responsibility on the city during the night. A man walking along at a place where the curb had been placed, but the sidewalk not yet fixed, hurt himself and it cost the city $250 for damages.

The engineer also made a suggestion. All incomplete work, he evidently considered, came under the clause where he could use his judgment; but he limited it to the construction actually in hand, and did not consider it as applying to any cleaning-up work. The writer replied that it was a matter of negligence upon his part, and the city was responsible. The putting-up of barricades or lights is so simple a matter that no man of common sense should take chances. The attorney was right in placing the responsibility on the city during the night; for the policing of the work is a public matter. Barricades and lights would have relieved both contractor and city. The omission of barricades and lights relieved the contractor, even if there had not been an express provision in the specifications throwing that duty on the employees of the city. But the city would not in any way be responsible for accidents happening during the day when the contractor and his men were on the ground.

Such clauses have to be framed with a knowledge of the provisions of the state laws and the city charter. In the above instance the clause was simply put in to throw the expense of safeguarding the work upon the contractor. There will be times when barricades and lights may be absolutely necessary, and it is well to fix upon who shall bear the expense. If nothing was said about it in the specifications, it is doubtful whether the contractor would be liable for damages received at a time when the work was left to the charge of the public officials. If nothing is said about it, the contractor will make a claim for extras if compelled to put up barricades.

Another engineer writes:

The contractor kicks, and says the half-inch I hold him to in the completion of the surface is too little leeway. He thinks an inch is close enough, provided the difference is so gradually spread over the surface that it does not make hills or hollows apparent to the eye. He says all differences which come within an inch and require the use of a level and rod to ascertain should not be fought over.

The writer sympathizes here with the contractor. The shaving and paring and adding "here a little and there a little" makes a lot of trouble. The writer would not have a depression of an inch near an extra elevation of an inch, but to have the surface of a macadam road so well-formed that it is nowhere to exceed half an inch from the theoretical curve is getting matters down to a fine point indeed. The writer, in his own work, endeavors to have the surface as uniform as possible, but has gone over work where differences of nearly an inch existed, and has approved it. Where the work has been completed so close to the requirements, and is in conformity with the specifications in every other way, it is passed. For this reason he does not state any acceptable limit, but tries to so set his fill pegs that when the road is rolled it will be everywhere not more than an inch from where the theoretical curve would have it.

RAIL SECTIONS FOR STREET RAILWAYS.*

By B. J. Arnold,† M. Am. Inst. Elec. E.

I have been requested to submit a design for a track rail which will be practicable for the operation of cars under Chicago conditions, and which will best protect the street pavements; also to report on the desirability and cost of laying cement roadbeds.

The design of track rail is of vital importance to a street railway company, and with the demand for better paved streets which has arisen in Chicago in later years the design is of equal importance to the taxpayer and the municipality.

In the absence of well paved and well maintained streets it would be a great hardship on the whole vehicular traffic of the city to demand the installation of a rail which would deprive vehicles of the roadway at present furnished by the girder tram rail now in use. The free movement of wheeled vehicles throughout a large proportion of the city would be materially retarded by the universal adoption of the girder grooved rail, and such change should be made only as new and permanent pavement is laid.

In the outlying districts—where the time between cars is infrequent—during the inclement weather of our winters, the grooved rail would frequently become clogged with ice that would prohibit the operation of cars until it was removed. This would not occur on streets where cars run at close enough intervals to clear the groove by the passage of the wheel flange. The girder grooved type of rail should not be installed on streets where contiguous population is insufficient to warrant a frequency of cars capable of clearing the groove.

There has grown up among the drivers of teams a habit of running the wheels on one side of their wagons in the outside car track, while the other wheels run on the paving. As the gage of the majority of vehicles is the same, and as this habit is very nearly universal, a depression is soon worn in the surface of the paving, destroying its appearance and life.

On account of this wear on the pavement, and from a desire to secure car tracks that can be crossed at any point on the street without transmitting a jolt to the vehicle, has arisen the demand for the full-grooved rail. The full-grooved rail is one where the flange of the rail is brought up flush with the head and is the ideal rail from the viewpoint of having the surface of the street present an unbroken surface; but such a rail cannot be cleaned by the passage of the wheel flange. The dirt will pack down in the groove until cars run off the track. The compromise is to lower the flange on the rail and grade the incline from the bottom of the groove to the top of the flange on such an angle that the dirt can be forced up the incline and out over the edge of the flange. If the flange is lowered too much a guiding shoulder for wagon wheels is created by the head of the rail and vehicles will follow the rail as much as they do the present tram rail, but an advantage is gained in that the wheels can climb the inclined flange and leave the track easily and without wrenching the running gear.

Fig. 1 illustrates the design of a rail section which has recently been adopted by the Rapid Transit Company of Philadelphia as its standard rail for use on streets as paved with asphalt, brick or dressed granite. This rail

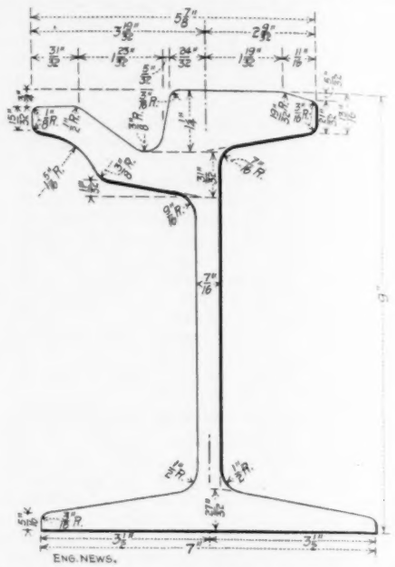


Fig. 1. Rail Section Adopted by the Rapid Transit Co. of Philadelphia.

weighs 135 lbs. per yd., and as designed presents some new and very valuable features which have not heretofore appeared in any of the designs for girder grooved rails, which have been manufactured. Its great weight and strength will be of material assistance in the production of a rigid and unyielding track. The increased breadth of tread with the slight bevel toward the back of the rail is a very important improvement for two reasons.

(1) It provides for the use of car wheels with broad treads which will present a greater surface for frictional resistance to brakeshoes, thus reducing the wear of brakeshoes and of the wheels.

(2) The beveled surface at the back of the tread of the rail will prevent the wheel from crushing or wearing the pavement where it comes in contact with the rail head. The web of this rail is brought nearly central under the bearing point of the head, which is a desirable feature where traffic is very heavy. The load is then transmitted more directly to the base without much tendency to cant the rail out. It also gives greater thickness of neck and consequently much more wear when used on curves.

The principal objection which may be raised against the Philadelphia rail is in respect to the projection of the head or tread of the rail above the outer edge of the groove flange, which amounts to 5-16-in. Although these flanges are so designed that it will not be difficult for any kind of vehicle to leave the tracks, the projection of the head above the flange is sufficient to invite teams to follow the tracks.

In Philadelphia the street railway company is charged with the entire cost of the maintenance of the paving on the entire street from curb to curb on all streets on which it has tracks, and as the tracks are principally single tracks this means some 500 miles of street. It is reasonable to suppose that where the railway company is responsible for the condition of the pavement outside of its tracks as well as within its tracks, the design of rail finally adopted would be the design calculated, in operation, to give the best results from all viewpoints. It certainly was not adopted to cheapen construction of tracks, as it is the heaviest girder grooved rail ever rolled. It must have been considered to be the best rail in reference to paving maintenance, as such maintenance is borne by the company and is bby far the greatest item of cost in connection with maintenance of way. On this basis of reasoning and from the fact that this rail is the latest rail designed, in the light of the rapidly advancing science of conducting transportation and in view of the demands of municipalities for better maintained pavement, I am prompted to submit the design of rail, shown in Fig. 2, which is similar to the Philadelphia rail, to meet the requirements of Chicago conditions, for use on streets,

*Extracts from the report to the Committee on Local Transportation of the Chicago City Council, Nov. 19, 1902. —See Engineering News, Jan. 1, 1903.

†Marquette Building, Chicago.

that are paved with asphalt, brick or dressed granite, when such pavement is kept cleaned and well maintained.

It will be noticed that the flange is only 5-32-in. below the head of the rail while the flange of the Philadelphia rail is 5-16-in. This change is made to reduce the invitation to teams to follow the tracks and with the understanding that it shall only be required to be laid as new pavement of asphalt, brick or dressed granite is laid. It would not be advisable to require its installation on un-

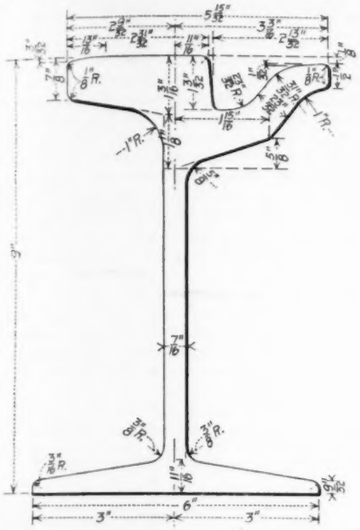
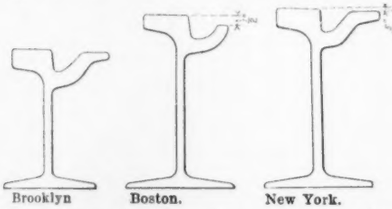


Fig. 2. Rail Section Recommended by B. J. Arnold for Well-Paved Streets in Chicago.

paved, or poorly paved streets and on streets paved with other material than asphalt, brick or granite.

Fig. 3 shows the rail used in New York city on newly paved streets, in the conduit electric railway construction. It will be noticed that the flange is only 5-32-in. below the head. As the streets on which it is installed are all well paved and kept admirably clean, no difficulty is found in operation.

Fig. 4 shows the rail used in Boston on paved streets.



Figs. 5, 4 and 3. Rail Sections Used in Brooklyn, Boston and New York.

This is known as the half grooved rail, the flange being ½-in. below the head. Considerable invitation to vehicles to follow the tracks is extended by this rail. Fig. 5 illustrates the rail used in Brooklyn.

Fig. 6 represents a very excellent type of street railway track construction in which "T" rails are laid on concrete beams. Ribbons of dressed granite are laid on each side of and flush with the upper surface of the rails. The granite blocks next to the gage side of the rails being

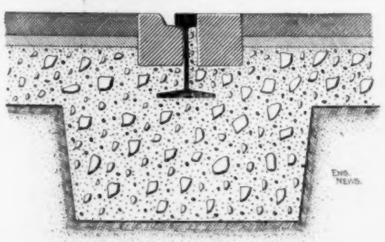


Fig. 6. T-Rail Laid on Concrete with Granite Paving.

dressed to form a groove for the passage of the flanges of the car wheels. This type of construction has been developed to the highest degree of perfection in the cities of Minneapolis and St. Paul, where it has been adopted as the standard street railway construction. Where the granite blocks are of good quality, well dressed to uniform dimensions and are properly laid on concrete foundations of sufficient strength, this type of track will give excellent service under moderately heavy vehicular traffic, and there are many streets in Chicago where track construction of this type could be installed with the assurance that it would give satisfactory results to all parties concerned. In a discussion with the officers of the leading asphaltic pavement company of this country, on the subject "Maintenance of Pavement in Streets Occupied by Railway Tracks," I was advised by these gentlemen that in their extended experience in maintaining under guaranty the pavements in such streets, that the most satisfactory results have been obtained in streets where the Minneapolis type of construction has been installed.

In reference to the desirability and cost of laying cement roadbeds for street car tracks:

Under the present operation of 25-ton electric motor cars, and considering the nature of the soil of Chicago, in order to obtain an absolutely unyielding foundation on which to lay tracks, it is necessary to lay cement concrete roadbeds. While the first cost of track construction is very largely increased thereby it is economy in the end for railway companies to adopt such practice. The cost of maintenance is reduced to the minimum and the street surface retains its even contour indefinitely thus securing the greatest life possible.

A further advance in the use of concrete in track construction has been made in dispensing with wooden crossties altogether and supporting the rails on concrete foun-

Fig. 7. Grooved-Rail Track Construction with Concrete Beam Support.

dations, burying the rail in concrete to the underside of the paving material, the rails being kept to gage by tie rods placed in the track at frequent intervals. The most approved practice in the use of concrete foundations is to lay the rails on longitudinal beams of Portland cement concrete, these beams being a part of the concrete foundation supporting the pavement. This method of construction is shown in Figs. 6 and 7, and if carried out with good material produces a substantial track which can be maintained under heavy traffic at a minimum cost and is most favorable for laying and maintaining street pavements.

The following is an estimate of the cost of one mile of single track constructed after such practice and using the design of rail recommended and shown in Fig. 2:

Excavation and hauling, 2,000 cu. yds. at $1.	$2,000
*Concrete beams, 800 cu. yds. at $6.	4,800
Steel rails, 120 lbs. per yd., 188.57 tons, at $41.	7,731
Hauling rails to street at $1.	189
Tie rods, 700, at 25 cts.	175
Cast welded joints, 176, at $5.	880
Cross bonding	10
Tracklaying, cleaning street, etc.	1,501
Special track work per mile of single track	4,500
Engineering, supervision and administration, 10%.	2,179
Total cost of track, exclusive of paving.	$23,965
If paved with asphalt.	$36,845
If paved with dressed granite	42,365
If paved with brick	36,615
Cost of paving: Asphalt (6-in. concrete base).	12,880
Dressed granite on 6-in. concrete base	18,400
Vitrified brick on 6-in. concrete base.	12,650

*These estimates fix the price of concrete in place at $6 per cu. yd. The price of concrete varies with the variations in the market price of cement and other materials, and with the varying conditions under which the work must be executed. The price of $6 per cu. yd. is considered to be a safe average price for the purposes of these estimates.

A DOZEN YEARS OF SEWAGE PURIFICATION EXPERIMENTS ON A LARGE SCALE AT SALFORD, ENGLAND.

At the recent meeting of the Sanitary Institute of Great Britain, Mr. J. Corbett, Borough Engineer of Salford, reviewed the various systems of sewage purification employed and experimented with by that borough since 1889. Salford is a "manufacturing town of nearly 250,000 inhabitants, where trade wastes in great variety are admitted to the sewers," as well as large quantities of surface water. The sewage purification works were constructed about 20 years ago, on a site of 34 acres, and additional land could not be obtained without great difficulty and expense. Fortunately, the borough has a wharf on the Manchester Ship Canal, from which it is able to ship sludge to sea at a moderate cost.

Of the various methods tested before the borough settled down to the present system of chemical precipitation, followed by rapid continuous filtration, Mr. Corbett says that Webster's electrolytic process "was in many points the most unique, most scientific and most successful," and although its "cost was somewhat high" it would have been adopted had the promoters been able "to finance so large a scheme." The process consisted (see Eng. News, Oct. 26, 1889, for general description) in the passage of sewage between cast-iron electrodes, giving an effect "much like that of chemical precipitants." The company's offer was to treat the sewage of the borough for 20 years at about 60¼ shillings per 1,000,000 Imp. gallons, or some $12 per 1,000,000 U. S. gallons.

The International process, using ferozone as a precipitant and polarite as a filtering medium, "was tried three times very exhaustively." Mr. Corbett thinks "polarite has not the valuable qualities claimed for it, and that better results can be obtained from the cheapest available materials, such as crushed clinkers, cinders and coke breeze."

After reviewing the various chemical precipitants tried, including Spence's aluminoferric, which latter gave a dense but relatively bulky sludge, Mr. Corbett proceeds with a description of the precipitation methods finally adopted, and also of the tests leading up to the rapid continuous filters used at Salford. This matter we have condensed somewhat to read as follows:

CHEMICAL PRECIPITATION.

The best and cheapest results have been attained by the use of lime and a salt of iron, either sulphate of iron (that is, copperas) or chlorate of iron, or some special persalt of iron. We now prepare the lime very carefully by the help of special machinery, first slaking the lime in circular pans with revolving stirrers, then passing the pan contents through a screen to separate out any stones, etc., and thence to other pans like mortar mills, with crushing rollers which promote the slaking of any hard granules of lime, the milk of lime being finally mixed with the whole flow of sewage in a tank with a revolving mixer, and where a great turmoil is made by the flow from the pumping engines, by which about 85% of our flow of sewage has to be raised 30 ft. to the precipitation tanks. The salts of iron are dissolved in a small tank by the help of steam, and then added to the flow of sewage about 700 ft. from the lime mixer, the stream passing from the iron mixing almost directly into the precipitation tanks.

The above-described precipitation system may seem antiquated in this era of septic tanks and contact beds, but our special circumstances render this more economical than any alternative I have yet studied. We have to deal with an old sewage works with precipitation tank of adequate size, and with only a moderate area available for filter beds or other appliances. It is, therefore, of the utmost importance to concentrate our work within a limited area; and as sludge can be sent to sea at the cost of less than 16 cts. per long ton, it is cheaper to dispose of it thus than by the use of extensive contact beds, tanks or other apparatus entailing heavy cost for construction and the use of valuable land. The ultimate purification of the sewage by filters, or bacteria beds, as they are now properly called, is also materially affected by the necessity for concentrated action.

SALFORD EXPERIMENTS ON SEWAGE FILTRATION.

Our dozen years' experimenting on the filtration of sewage tank effluents has been especially interesting and convincing to me, seeing that I had from boyhood assisted my late father in various processes of sewage treatment, and commenced these experiments with the then orthodox faith that land alone could adequately purify sewage, and that a filter was only an intercepter of filth which must soon become choked. An entirely new knowledge has arisen within approximately this period, and having closely followed the records of the experiments of the State Board of Massachusetts, those of the Metropolitan Board of Works and their successors, the London County Council, and many other experiments, and having considered all these in connection with the actual experiments under my own observation at Salford, I come to the conclusion that for all densely populated districts tanks and filters of one kind or another are preferable to sewage farms, and are more economical. I also definitely conclude that no patent material for the construction of sewage filters is worth its cost, and that mere cinders, which can be obtained cheaply anywhere where coal is the ordinary fuel, are probably the very best material for such filters or bacteria beds.

I will now briefly trace our filtration experiments, only premising that while these filters were on trial we were also trying various precipitation systems in the tanks, and so the tank effluent was sometimes of bad quality, but generally fairly good. Analyses were taken daily on samples taken about hourly, and I will give averages of the results attained, as a full detailed account would be too lengthy. These filters have always been used on the trickling system with open outlet for filtrate and spent air. We never tried the system of filling, standing full and then emptying, as it seems to me illogical, and does not deal with so large a flow as the trickling system.

After about twelve months' comparison of couples of filters, each of 14 sq. yds. area, formed respectively of gravel, of coke-breeze and of cinders, the cinders proved slightly the most efficient.

We tried distribution over the filter surface by embedded troughs and a 3-in. top of fine sand, but this soon got clogged and had to be renewed each month or two. We then tried troughs about 1 ft. above the surface, with small holes about 1 ft. apart, and bits of board to break the small streams into drops over the surface. These did very well, but hindered the daily raking of the filter surface, which we found requisite to ensure proper aëration.

We now begun to use roughing filters, made of 3-ft. depth of gravel, or of small broken granite to intercept any particles of wood, rag, straw, etc., in the precipitation tank effluent, and thus prevent their choking the surface of the final aërated filter beds. Finding the distribution by sprinklers very efficient, we removed the former top stratum of sand, and made all the future filters of one grade from top to bottom, that is, between riddles of two wires and of six wires to the lineal inch, but with a few inches of coarser material on the floor tiles.

We then tried sprinkler jets set in pipes about 1 ft. above the surface, and worked under about 4 ft. head of water. This system proved far the best in every way, but our first jets, though very efficient, were imperfect in that they dribbled somewhat and formed pools on the surface below each jet; these were simple upright nozzles about ¾-in. diameter, with brass disks or cones over them to break the stream into drops. Our second type of sprinkler jet was formed with two ¼-in. holes inclined towards each other like an old-fashioned gas jet; this was somewhat better, but dribbled slightly. Ultimately we got a jet where the water is set whirling by passing through inclined holes in the lower part of the jet before reaching the top outlet, and this whirling movement throws out the water in a very fine spray over a circle of about 12 ft. diameter; and as the jets are spaced 10 ft. apart north and south, and 5 ft. 2 ins. apart east and west, the whole surface is very evenly sprinkled. But these jets are rather more difficult to clean out than the simpler ones, and all show a slight tendency to become coated with lime, more especially if a large quantity of this material is used as a precipitant

We tried filters about 5 ft. deep, some with three ventilated spaces in the height, some with two, some with one, and some ventilated only at the floor outlet. We also tried filters 8 ft. deep, one with three intermediate ventilated floors and the outlet floor, the other with only the outlet floor. These floors were made of tiles or slates supported on bricks, and with couples of vent-pipes to each floor. The best results were obtained from the filters without any intermediate floors.

We tried filters in one height of cinders, one of 3 ft. 6 ins. depth, one of 5 ft. and one of 8 ft. depth. The 8-ft. one proved definitely the best, more especially when reasonable worked: but when overworked with somewhat foul tank effluent all the filters gave inferior filtrates, and for a time the 8-ft. was worse than the 5-ft., but on the average it was decidedly the best.

From the first we proposed about 3,000,000 gallons* per acre as the standard flow to be treated: but after gradually raising the daily flow, during, say twelve hours, to this pitch, we increased it with two of the 5-ft. filters up to 8,400,000 gallons per acre, before the filtrate became definitely below the standard of 1 gr. of oxygen per (Imp.) gallon in a four hours' test. Two 8-ft. filters were worked for about a year at 3,000,000 gallons in twelve hours, leaving twelve hours' resting time per day. They were then worked about 23 hours per day at 6,000,000 gallons per sq. yd. for a year, with a few slight intermissions during repairs of the steam pump supplying them. The filtrate channel from these filters became coated with a bright green growth, considered to be a sign of a good filtrate; but a small quantity of sewage fungus appeared at times in the outlet pipes.

We found definitely that whenever sludge was allowed to accumulate in the tanks an inferior effluent resulted. This appeared to be due, firstly, to the loss of tank capacity from the mass of sludge collected in the tanks; and secondly, to the putrefaction of this sludge, and its rising on gas bubbles into the upper part of the tanks, thus seriously fouling the sewage in the tanks. I believe the best results would be obtained by removing the sludge from the tanks daily, and this should be done while the tanks are in use by suitable apparatus, of which several types are available.

Having originally a dozen precipitation tanks, we made arrangements for using eight or ten of them separately, each with one-eighth or one-tenth the flow of sewage; we also tried four couples of tanks, each dealing with one-fourth of the flow, the remaining tanks being meantime cleared of sludge. We generally used the tanks as one series of six, the other six being meantime cleaned. They were once tried all twelve in series. The chemical analyses showed but slight differences in the effluents from these various systems, and slightly the best effluent was obtained from six tanks used in series.

The tanks in each set of six had originally a fall of 3 ins. from tank to tank, but this appeared to interfere with the precipitation, and a great improvement was effected by constructing a dam at the outlet of one set, so as to submerge these falls and make one pool from end to end of the six tanks.

*U. S. gallons have been substituted throughout.—Ed.

All our tanks were eventually altered by lowering their division walls about 3 ft., so as to make a very quiet pool from end to end; but as two tanks were required for use as roughing filters, each tank is now made from five of the original tanks. The result has been remarkably successful, less than half the chemical precipitants formerly used now proving sufficient to give a satisfactory effluent. This is with sludge removal once a week, in place of once a fortnight or once a month as previously practised. So it seems certain that if the sludge were removed once a day still better results would be obtained.

This tank effluent is passed through roughing filters of gravel 3 ft. deep, similar to those used during nearly all the filtration experiments. The special use of these roughing filters is to intercept particles of rag, wood, straw, etc., which would tend to choke the surface of the final filters. During the experiments it was found that 75% of the matters in suspension were thus removed from the tank effluent. This result was attained when the roughing filters had a reversed current upward washing each day, and had the gravel dug out and washed under a stream of water about three itmes a week. Up to the present time the permanent roughing filters have not been provided with washing apparatus, except mere upward washing, and recent analyses showed that they are intercepting only from 25 to 50%, instead of 75% of the matters in suspension. Thus the sewage works are still incomplete, and the excellent results attained during the many years of experimenting are not yet attained in the daily working on a large scale. When the requisite machinery, etc., is provided for removing sludge from the precipitation tanks, and for washing and raking the roughing filters and bacteria beds, I have no doubt that results as good as those from the experiments will be obtained with the whole flow of sewage, and even with a considerable addition of storm water at times; and thus these long continued experiments will result in a sewage purification system more economical in first cost, and probably also in working cost, than any system yet adopted in a large manufacturing town.

A more detailed description of the filters built by Mr. Corbett at Salford, with a half-tone view, was given on pp. 155-6 of our issue of Aug. 28, 1902, as a part of a paper by Prof. Leonard P. Kinnicutt, of Worcester, Mass., on "The Present Status of the Sewage Disposal Problem in England."

SOME USEFUL DATA FROM SCOTCH MARINE ENGINEERING PRACTICE.

By H. Wilkes.*

The report of the comparative tests of the Scotch and American engines in the Glasgow municipal tramway power station has called attention to the difference in practice between the designers of the two countries. Although the specifications and general proportions submitted by better. Of the four engines of 4,000 HP. each, two were supplied by the E. P. Allis Co., of Milwaukee, and two by Musgrave & Co., of Glasgow. Tests made by Prof. Barr showed that while the power developed and the mechanical efficiency (about 96%) were almost identical, the Allis engines gave an indicated horse-power per hour on 12.2 lbs. of steam, and the Musgrave engines required 13.4 lbs. of steam per indicated horse-power. Thus the American-built engines indicated about 10% better result.

It was pointed out that it would be manifestly unfair to interpret the results as showing a su-

*Engineer of Hoshor Platt Co., 120 Liberty St., N. Y.

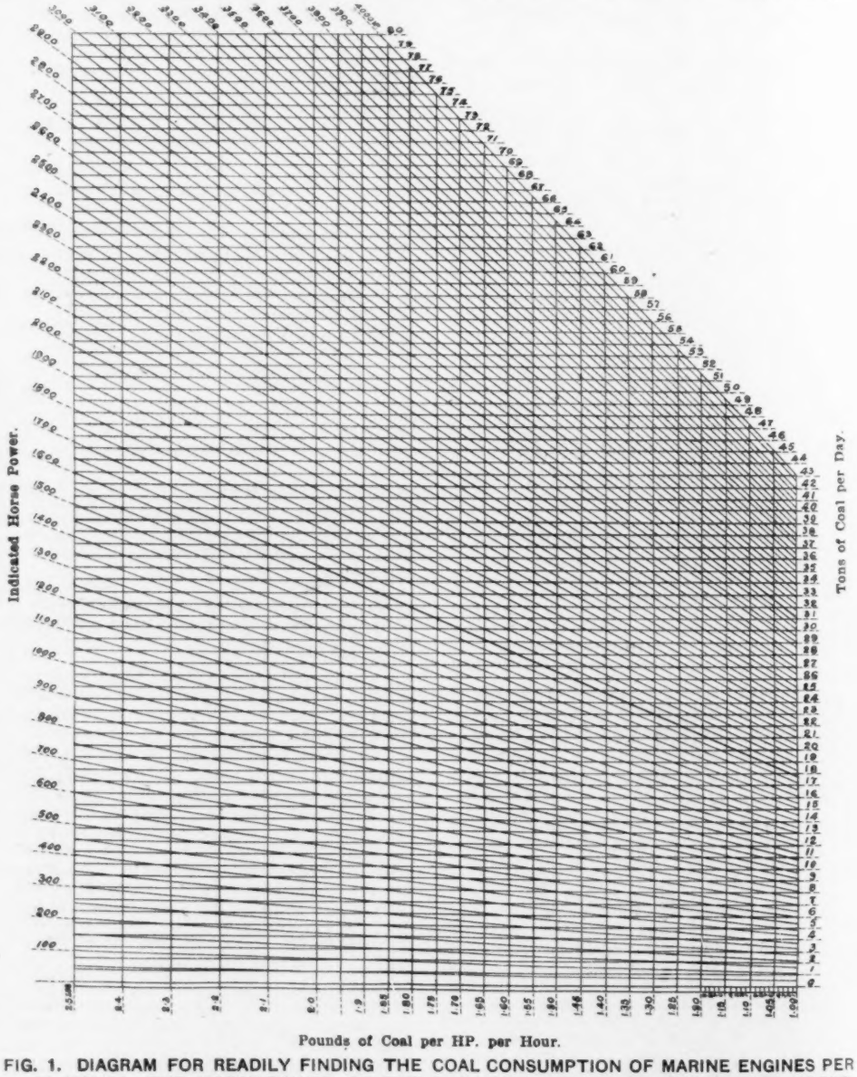


FIG. 1. DIAGRAM FOR READILY FINDING THE COAL CONSUMPTION OF MARINE ENGINES PER 24 HOURS, THE HORSE-POWER OF THE ENGINES, AND THE COAL BURNED PER HORSE-POWER HOUR BEING KNOWN.

periority in engineering design of the one country over the other, for the construction of great electric power houses in the United States has given the engineers of this country data and experience in the design of stationary engines of large capacity not yet available to the designers of other nations.

In marine engineering work, however, the preponderance of experience has been on the other side of the water. The engineering world has grown beyond and little recognizes national boundaries, so that reciprocity in data and experience is now well-nigh universal. Every broad-minded engineer recognizes that the greater part of the valuable information in his private data book comes from the work of others, and in a measure should be available to his co-workers. The accompanying table and diagrams are taken from the leaves of the writer's pocket-book, all the figures being based upon engines, boilers and accessories actually constructed in Scotch shipyards.

Fig. 1 is a handy short-cut for determining the daily coal consumption of marine engines, the power and efficiency

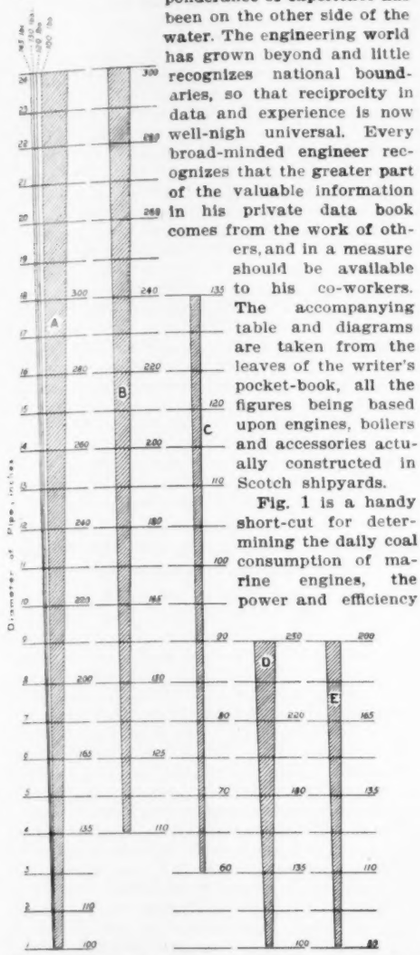


Fig. 3. Diagram for Determining Thickness of Copper Pipes According to Rules of British Board of Trade.

Advancing by 1-32-in. to every 10 lbs. of pressure.
NOTE.—The thickness of A and D are suitable for working pressures up to 100 lbs. per sq. in., and in proportion for higher pressures.

Reference.
A—Main and Auviliary Steam Pipes and Fire Pipes.
B—Main Water Pipes.
C—Waste Steam Pipes.
D—Feed Delivery Scum Blowoff and Bilge Pipes.
E—Feed Suction Pipes.
The approximate thickness by Whitworth's gage is shown by figures alongside.

being known. Figs. 2 and 3 are diagrams plotted from the prescribed thickness of copper pipes for given diameters and pressures, as given by the British government and the Board of Trade. It will be noted that the government requirements as shown by the first diagrams are less rigid than those of the Board of Trade.

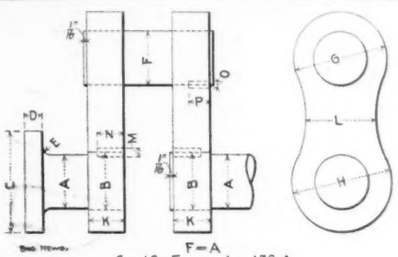
The table giving sizes of parts for crank shafts will be found very useful for reference in designing the details of cranks, pins, etc., for all parts have stood the test of actual service, being of ample proportions to carry their respective stresses and presenting adequate bearing surface.

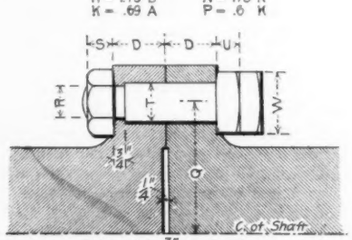
INCREASING THE EFFICIENCY OF COMPRESSED AIR AT THE BISBEE WEST MINE.

It is possible to prove theoretically that if the exhaust air from an air driven pump, or drill, be carried back to the compressor and used over again, there results a very great increase in the efficiency of the plant. In a recent issue of the "American Machinist," Mr. Frank Richards gives

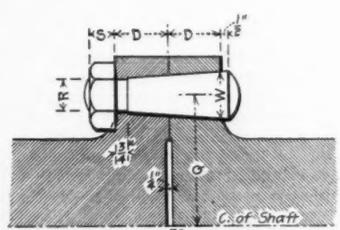
TABLE FOR PROPORTIONING CRANK SHAFTS OF MARINE ENGINES.
(All dimensions represent inches.)

A.	B.	C.	D.	E.	F.	G.	H.	K.	L.	M.	N.	O.	P.	Q.	R	S.	T.	U.	V.	W.	No. of bolts.
10	11	19½	2⅞	1½	10	18	19¼	6⅞	13¾	1¾	5¼	1¼	4	7⅞	2	1⅝	2⅜	1¼	3⅜	2½	6
10¼	11¼	20½	3	1½	10¼	18½	19⅜	7	14¼	1⅞	5¼	1¼	4	8	2⅛	1⅝	2½	1¼	3¼	2⅝	6
10½	11½	20½	3	1½	10½	18⅞	20⅛	7¼	14½	2	5½	1½	4¼	8	2⅛	1⅝	2½	1¼	3¼	2⅝	6
10¾	11¾	21½	3¼	1½	10¾	19⅜	20½	7⅜	14¾	2	5½	1½	4¼	8⅜	2¼	1⅝	2⅝	1⅜	3 15/16	2⅝	6
11	12	21¾	3¼	1⅝	11	19⅞	21	7½	15⅛	2	5⅝	1½	4½	8⅝	2¼	1⅝	2⅝	1⅜	3 15/16	2⅝	6
11¼	12¼	22⅛	3⅜	1⅝	11¼	20¼	21¼	7⅝	15½	2	5⅝	1¼	4½	8⅝	2⅜	1⅞	2¾	1⅜	4⅛	3	6
11½	12½	22½	3½	1⅝	11½	20⅝	21⅞	7⅞	15⅞	2¼	6	1½	4⅝	8⅝	2⅜	1⅞	2¾	1⅜	4⅛	3	6
11¾	12⅞	23½	3⅝	1⅝	11¾	21⅛	22⅜	8	16¼	2¼	6	1½	4⅝	9⅛	2⅜	1⅞	2⅞	1½	4 5/16	3⅛	6
12	13	23½	3⅝	1⅝	12	21⅝	22⅞	8¼	16½	2¼	6¼	1½	4⅝	9⅛	2⅜	1⅞	2⅞	1½	4 5/16	3⅛	6
12¼	13½	24⅛	3½	2	12¼	22	23⅜	8⅜	16⅞	2¼	6½	1½	5	9½	2½	1⅞	3	1½	4½	3¼	6
12½	13¾	24½	3½	2	12½	22½	24	8⅝	17¼	2¼	6½	1½	5	9½	2½	1⅞	3	1½	4½	3¼	6
12⅞	14	25	3⅝	2	12⅞	23	24½	8⅞	17½	2¼	6½	1½	5¼	9 3/16	2½	1⅞	3¼	1⅝	4⅜	3⅜	6
13	14¼	25	3⅝	2	13	23⅜	25	8⅞	17⅞	2½	6⅝	1⅝	5¼	9 3/16	2½	1⅞	3¼	1⅝	4⅜	3⅜	6
13¼	14½	26	3¾	2	13¼	23⅞	25⅜	9¼	18¼	2½	7	1¾	5¼	10	2⅝	2	3¼	1⅝	4 15/16	3½	6
13½	14⅝	26	3¾	2	13½	24⅜	25⅞	9¼	18⅝	2½	7	1⅝	5½	10	2⅝	2	3¼	1⅝	4 15/16	3½	6
13¾	15	27	4	2	13¾	24¾	26¼	9⅜	18⅞	2½	7	1⅝	5½	10⅛	2⅝	2	3⅜	1¾	5⅛	3⅝	6
14	15¼	27	4	2¼	14	25¼	26⅝	9⅝	19¼	2½	7¼	1⅝	5⅝	10⅝	2⅝	2	3⅜	1¾	5⅛	3⅝	6
14¼	15½	28	4⅛	2¼	14¼	25⅝	27⅛	9⅝	19⅝	2½	7½	1⅝	5⅝	10⅝	2⅝	2	3½	1¾	5 5/16	3⅝	6
14½	15⅞	28	4⅛	2¼	14½	26	27½	10	20	2½	7½	1⅝	6	10	2¾	2	3½	1¾	5 5/16	3⅝	6
14⅝	16	29	4¼	2¼	14⅝	26½	28	10⅛	20¼	2½	7⅝	1⅝	6	11⅛	3	2¼	3⅝	1⅞	5 9/16	3⅞	6
15	16¼	29	4¼	2¼	15	27	28½	10¼	20⅝	2⅝	7⅝	1⅝	6	11⅛	3	2¼	3⅝	1⅞	5 9/16	3⅞	6
15¼	16½	27½	4½	2¼	15¼	27½	28⅞	10½	21	2⅝	8	1⅝	6¼	10⅝	2½	1⅞	3¼	1⅝	4⅜	3⅜	9
15½	16¾	27½	4½	2¼	15½	27⅞	29⅛	10⅝	21⅝	2¾	8	1⅝	6¼	10⅝	2½	1⅞	3¼	1⅝	4⅜	3⅜	9
15¾	17	28½	4½	2¼	15¾	28⅜	29⅜	10¾	21⅞	2¾	8¼	1⅝	6¼	11¼	2⅝	2	3¼	1⅝	4 13/16	3⅜	9
16	17¼	28½	4½	2½	16	28⅞	30¼	11	22	2¾	8¼	1⅝	6½	11¼	2⅝	2	3¼	1⅝	4 15/16	3½	9
16¼	17⅝	29¼	4⅝	2½	16¼	29¼	31⅛	11¼	22⅜	2⅞	8½	1⅝	6½	11½	2⅝	2	3⅜	1¾	5⅛	3⅝	9
16½	18	29¼	4⅝	2½	16½	29⅝	31½	11⅜	22⅝	2⅞	8½	1⅝	6¾	11½	2⅝	2	3⅜	1¾	5¼	3⅝	9
16¾	18¼	30¼	4½	2½	16¾	30⅛	32	11½	23	2⅞	8⅝	1⅝	6¾	11⅞	2¾	2	3½	1¾	5 5/16	3¾	9
17	18½	30¼	4½	2½	17	30⅝	32⅜	11⅝	23⅜	2⅞	8¾	1⅝	6¾	11⅞	2¾	2	3½	1¾	5⅜	3⅝	9
17¼	18¾	31½	4⅝	2½	17¼	31	32⅞	11⅞	23⅝	2⅞	9	1¾	7	12⅛	3	2¼	3⅝	1⅞	5 7/16	3⅞	9
17½	19	31½	4⅝	2½	17½	31½	33¼	12	24⅛	2⅞	9	1¾	7	12⅜	3	2¼	3⅝	1⅞	5 7/16	3⅞	9
17¾	19¼	32	4¾	2½	17¾	32	33⅝	12⅛	24⅜	2⅞	9¼	1¾	7¼	12⅝	3	2¼	3⅝	1⅞	5 7/16	3⅞	9
18	19½	32	4¾	2½	18	32⅜	34⅛	12⅜	24⅞	2⅞	9½	1¾	7¼	12⅝	3	2¼	3⅝	1⅞	5 7/16	3⅞	9





Bolts with 3/8" per Ft. Taper
Parallel Bolts same as above Diam.=T



Bolts with 3/4" per Ft. Taper

some data of an actual test secured from Mr. F. H. Wheelan, President Pneumatic Power Co., 224 California St., San Francisco. The data follow:

I am enabled to present here some data from an installation of this system at the Bisbee West Mine, near Bisbee, Arizona. The plant consists of the following: One Ingersoll-Sergeant Straight-Line air compressor, steam cylinder 16 ins. diameter, air cylinder 12¼ ins., stroke 18 ins.; one Cameron station pump, air cylinder 16¼ ins. diameter, plunger 6½ ins. diameter, stroke 18 ins. A 6×6×6-in. auxiliary air compressor is connected to the low-pressure pipe line to supply leakage in pipe line, thus keeping the pressure constant at any desired point. The duration of the test here recorded was 70 minutes.

Average Temperatures.

	Degrees F.
Inlet to compressor	69¼
Receiver	162
Inlet to pump	88.8
Discharge from pump	51.6
Station	72
Engine-room	93

Gage Pressures.

	Pounds.
Inlet to compressor	83
Discharge from compressor	158.3
Inlet to pump	152.6
Discharge from pump	90.9

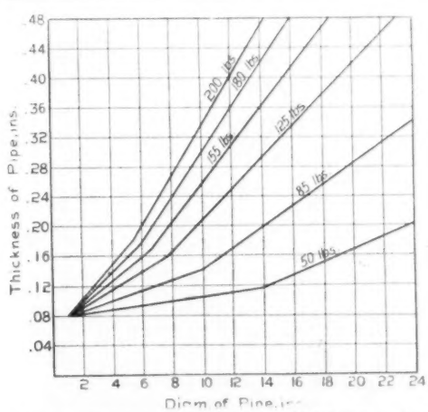


Fig. 2. Diagram for Determining Thickness of Copper Pipes According to Rules of British Navy.

No pipe to be less than thickness indicated.
Bends and T's are to be not less than one L. S. G. thicker than the plain pipe.
All steam (not exhaust) and bilge pipe up to 4½-in. diameter and all feed and blowoff pipe are to be solid drawn.
Steam pipe are to be not less than shown by the diagram for the safety valve pressure indicated.
Feed discharge and blowoff pipes are to be as for steam pipe of 30% greater pressure, but in no case less than for 125 lbs. pressure.
Feed, suction, bilge and discharge and fire service pipes are to be as for steam pipes of 125 lbs. pressure.

Mean Effective Pressures in Cylinders.

	Pounds.
Compressor	65.6
Pump	61.7

Speed.

	R. P. M.
Compressor	56.35
Pump	19.9
Auxiliary compressor	98.7

Work.

Total indicated foot-pounds in air cylinder of compressor per minute	1,268,400
Total indicated foot-pounds in air cylinder of pump, per minute	751,500

The power thus indicated at the pump is 59% of that of the compressor cylinder, while with the usual compressed air practice in driving a steam pump in this way it is rarely that more than 25% is realized.

This plant is criticised for its deficiencies by the operator of another dense air plant, where a rock drill is operated instead of a pump. The drill is 1,800 ft. from the compressor, and there are two lines of 2-in. pipe 1,300 ft. long and two lines of 1½-in. pipe 500 ft. long. The working pressure is from 215 to 220 lbs., and the return pressure 95 to 100 lbs. Notwithstanding that it is much more difficult to keep the piping around a drill tight than it is around a pump, the auxiliary compressor to make up the leakage is not run more than a quarter of the time. The compressor in this case, with air cylinder 5 ins. diameter by 9 ins. stroke, runs 90 to 95 turns per min., and besides driving the 2¾-in. rock drill in "the hardest rock I have ever seen" it also runs a 5×6-in. slide valve engine eight hours a day to drive a blower, and pumps 8,000 gallons of water 200 ft. high. The joints of the pipes in this case were made with shellac, which the engineer claims accounts for the small leakage. He also suggests that the pipes at the Bisbee West Mine are too small, being 2½ and 3 ins. instead of 3 and 4 ins., the latter of each of course being for the exhaust.

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ADVERTISING RATES: 20 cents a line. "Want" and "For Sale" notices, special rates, see page XXIV-XXIX. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.

Five tons of dynamite was recently condemned at Fort Pickens, a military post, ten miles from Pensacola, Florida. Disintegration or "rotting" of nitro-glycerin is particularly rapid in a warm climate, and dynamite becomes peculiarly sensitive to shocks when the nitro-glycerin it contains is partly disintegrated. The condemned dynamite, according to newspaper accounts, was taken out and placed on the beach about a mile from the fort, and set fire to. It was apparently expected that the dynamite would merely burn up rapidly without detonating, but it exploded with great violence, tearing a hole in the beach "as big as a house," shattering windows in Pensacola, ten miles away, and "painfully shaking" the men at the fort.

The lesson to be drawn from this experience is that spoiled dynamite cannot be safely destroyed by burning it—especially in large quantities. It should be burned only in very small quantities if at all; but in this particular case perhaps the safest and quickest way would have been a deep-sea burial, for the sea water would quickly complete the work of disintegration and dissolution.

According to a recently-published statement, the city of New York has no authority to place water meters in private residences. If this be true, it shows an absurd restriction by the state on municipal action, which ought to be removed; not only in New York city, but in every city of the state, and not only in the state of New York, but in every state of the Union. If cities are given the right to provide and distribute water to their citizens, they should also be given the right to sell the water in such manner as they may decide to be best, subject only to the general jurisdiction of the courts.

Even were we to accept the views of those conservative ones who oppose the general application of meters to residences, municipal water departments should certainly have authority to apply meters wherever there is reason to expect that waste exists. House-to-house inspection is of little avail to control wilful or careless waste of water, since the inspector's back is scarcely turned before the same habits of waste may be resumed.

The small staff of the Statistics Department of the city of Boston has done much good work since the department was created, some six years ago. Having by this means made itself worthy of the public confidence, and having proved its usefulness to various city officials finding themselves suddenly in need of statistical information, the trustees of the department have addressed a circular to the mayor outlining fields of further usefulness. These include annual detailed statements of the city's assets and liabilities, "giving a clear description of each asset, the original cost of it, the 'betterments' outstanding or collected and applicable to reduce cost, the original and present debt corresponding to each asset, and other facts relating thereto;" also annual statements of the amount of money "spent on each street for sewers, water pipes, construction or repairs, together with the amount of betterments due or paid, the number of lines and the purposes for which the street has been dug up"; and also "tables showing the comparative cost and results of the same work in this and other cities." "Before comparative statistics can be published" the statistics relating to Boston must first be got into shape." To do these and other useful things, the trustees say, a larger staff of trained investigators is needed, together with an annual appropriation of $50,000 for expenses, and an ordinance requiring heads of city departments to report to the Statistics Department such information and in such form as may be requested. As the trustees well say: "Boston has taken the lead in establishing a bureau of statistics. It should take the lead in making that bureau (more—Ed.) effective and valuable."

The abuses connected with public advertising by means of signs and posters placed with little or no regard to private rights or to their esthetic effect is beginning to arouse no little protest in this country, as it has for some time past abroad. The subject has just been taken up in a vigorous manner by the American Park and Outdoor Art Association, through its president, Mr. Clinton Rogers Woodruff. Mr. Woodruff has issued a circular urging cities and towns "to adopt ordinances imposing fines for advertising on electric light, telegraph, telephone and street car poles, trees and tree boxes." The association has also prepared a bill, for introduction into state legislatures, prohibiting advertising signs on public buildings or grounds except as required by law, and also prohibiting such advertising on private property without first obtaining the written consent of the owner of the property so used. The move is certainly a most commenable one. Copies of the circular, including a bill to control public advertising, already introduced in the Pennsylvania legislature, can be obtained from Mr. Woodruff by addressing him at the North American Building, Philadelphia.

The fearful grade crossing disaster in Newark on Feb. 19, in which an electric street car crowded with school children was struck and demolished by a passenger train at a grade crossing of the Delaware, Lackawanna & Western R. R., furnishes an added argument for those who have opposed the crossing of steam and electric railways at grade. Speaking with full knowledge not alone of this latest horror, but of the hundreds of other cases of collision which have occurred at such crossings, we say emphatically, that the manufacture of such death traps should be stopped. In New York, by a law passed in 1902, no new grade crossing of a steam railway by an electric railway can be made except by consent of the State Railroad Commission. A similar act has long been in force in Massachusetts and the commission of that state is granting no permits for such crossings except for temporary purposes, and they are then only made for a limited period of a few months. With proper provision of interlocking signals and derailing switches, a grade crossing of two steam railways can be made safe enough to be permissible; but a grade crossing of an electric railway and a steam road under existing conditions is not and cannot be made safe. Its dangers can be reduced, indeed, by the employment of various precautions; but the best of these fall far short of making any such crossing really safe.

We trust that one result of the recent railway accidents in New Jersey may be the establishment of a State Railroad Commission. We say this with full knowledge of what state railway commissions in other states have accomplished as well as what they have not accomplished. It is commonly said, and probably with truth, that one reason why New Jersey and several other states have no railroad commissions is the influence of the railways in state political mattters. Whether this be true or not, we venture to say that there is no reason why in their own interest the railways at the present day should oppose the creation of state railroad commissions. The fact is that these commissions, taken as a whole, have been a very considerable power for good in advancing railway practice to a higher and safer standard and in assisting in the maintenance of good discipline and a high record of fidelity among railway officials and employees. Certainly the interference of railway corporations with legislation deserves severe condemnation, but in this particular instance, we would point out that it is actually contrary to their own best interests.

THE NEW YORK BARGE CANAL AND THE FEDERAL DEEP WATERWAY: A COMPARISON.

When the project for a 1,000-ton barge canal from Lake Erie to the Hudson River was first brought forward by Major T. W. Symons, in 1896, the editors of this journal were strongly inclined in its favor. It was at that time claimed that such a canal could be constructed for not more than $50,000,000; and the evidence then available appeared to show that it would be a more economical transportation route, taking its cost into consideration, than any channel of greater depth.

There had been much agitation previous to that time for a ship canal connection from the Lakes to the sea, deep enough for ocean vessels; but this project we had opposed, believing that its cost would be too great to make it commercially practicable and that a waterway of smaller dimensions and much less cost would answer every purpose.

It must be said, however, that until within a very short time the information on which to base a sound opinion on this subject has been lacking. It was not until the results were made public of the elaborate surveys and estimates made by the United States Deep Waterway Commission and of the barge-canal surveys, made under direction of the State Engineer of New York in 1900, that an intelligent comparison of these different waterway projects was possible.

We have given careful study to the reports of these two surveys and we are obliged to favor the deep waterway proposed by the United States Commission of engineers as far preferable to the 1,000-ton barge-canal project, which the New York legislature is now considering.

On another page of this issue we have presented a description of the Federal deep waterway. We wish here to make a comparison of the two projects and to present some of the reasons why the construction of the larger waterway is far preferable in the public interest.

Perhaps the best idea of the relative size of the two waterways can be gained by an examination of Fig. 1, which shows the standard cross-sections, in earth and in rock, adopted for each. It will be seen that the cross-section of the deep waterway is between four and five times as large as the cross-section of the barge canal. The small canal is practically a channel for large canal boats and nothing else. The large waterway is a channel for ships, capable of passing every vessel navigating the Great Lakes and probably four-fifths to nine-tenths of the vessels engaged in ocean commerce as well.

Turning now to the cost of the two channels, we

find, taking the engineers' estimates in each case, that the smaller canal will cost to construct a little over $80,000,000, while the larger canal will cost a little less than $200,000,000. It may seem surprising to some readers that the difference in cost should not be more in view of the great disparity in size of the two channels, as shown in Fig. 1. While many reasons for this will suggest themselves to an engineer, there is one controlling reason which deserves emphasis and that is the difference in character of the two routes. The accompanying map, Fig. 2, shows the general route of the Federal deep waterway. The barge-canal route differs from this, in that it follows the line of the old Erie Canal from Lake Oneida west. Thus the characteristic feature of the deep waterway is the utilization of natural water channels, with the least distance of actual canal excavation.

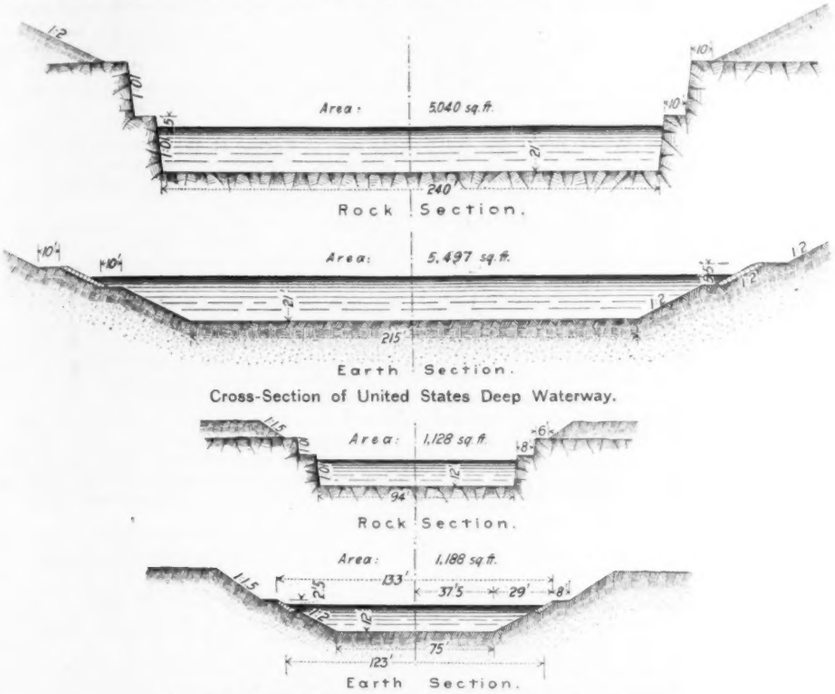


FIG. 1. STANDARD CROSS-SECTIONS ADOPTED FOR PROPOSED WATERWAYS FROM LAKE ERIE TO THE HUDSON RIVER.

The official estimate, made by engineers who stand at the head of their profession in this country is that a vessel could make the voyage from Buffalo to New York city in 64 hours, or only 2 days and 16 hours. This is not a mere guess. The Commission's report devotes an entire chapter to this subject alone and its conclusions are shown to be based on what similar vessels are actually doing in similar channels. While there are no waterways of such length in existence, there are ship canals and ship locks through which large vessels have for years been handled, and these figures are based on that experience.

In contrast with this, we may place the engineers' estimate of the time required for a vessel in the proposed barge canal to go from Buffalo to Troy only. It varies from 84 to 108 hours, according to the speed adopted; but the engineer advises that the additional cost of the power necessary for the higher speeds in the shallow barge canal would make them uneconomical.* If we add to this 108 hours the time required for the run with the barges down the Hudson River from Troy to New York (engineer's estimate of speed in open water, 4.4 miles per hour), we have a total of 140 hours as the engineer's estimate of the running time from Buffalo to New York by the proposed barge canal, or considerably more than *twice* the time necessary for a Lake vessel to make the passage between the same points through the proposed deep waterway.

We believe that this matter of speed of transit is one on which the advocates of the barge canal are wholly uninformed. The argument is repeated time and again in the public prints and even in the legislature: "Oh, there's no use in building a ship canal from the Lakes to the Ocean; for neither ocean vessels nor lake vessels can afford to travel through a 350-mile canal at three or four miles an hour."

We respectfully submit to those who have been using or have been influenced by this argument that it is very far from the facts. In the deep waterway which the Government's engineers have located, the length of actual canal from Buffalo to New York is only 100 miles. This canal is large enough for the Lake steamers to run through it at eight miles an hour speed, and the total time for the voyage from Buffalo to New York is less than three days.

The importance of this feature of quick transit, in enabling the waterway to compete with the railways, in the carriage of high-class merchandise as well as the carriage of such goods as coal and ore and grain, is evident to anyone. Suppose steamers could load at the wharves of New York and be sailing down Lake Erie three days afterward. Or, on the other hand, suppose a steamer leaves Duluth or Chicago with a cargo of grain or flour. Her voyage to Buffalo takes from three to four days and by continuing her voyage less than three days more she can land her cargo direct at the wharves of New York city, without transfer or delay.

Do the commercial organizations of New York city, whose influence is being used to further the barge-canal bill in the New York legislature, appreciate what this would mean? The astonishingly low cost of freight carriage between Duluth and Chicago and the other upper lake ports and the cities on Lake Erie is well known. Do New York city merchants and shippers realize that by a deep waterway a steamer would take less time to go from New York city to Buffalo than is required to go from Buffalo to the upper lake ports? Further, inasmuch as freight rates by water do not increase directly with the increase of voyage (the cost of loading being the same whether the voyage be long or short), the freight rates for water carriage between New York city and the ports on Lake Michigan and Lake Superior should be much less than double those now prevailing between these ports and Buffalo.

Nor would New York alone be the gainer. The same vessel without breaking bulk could proceed

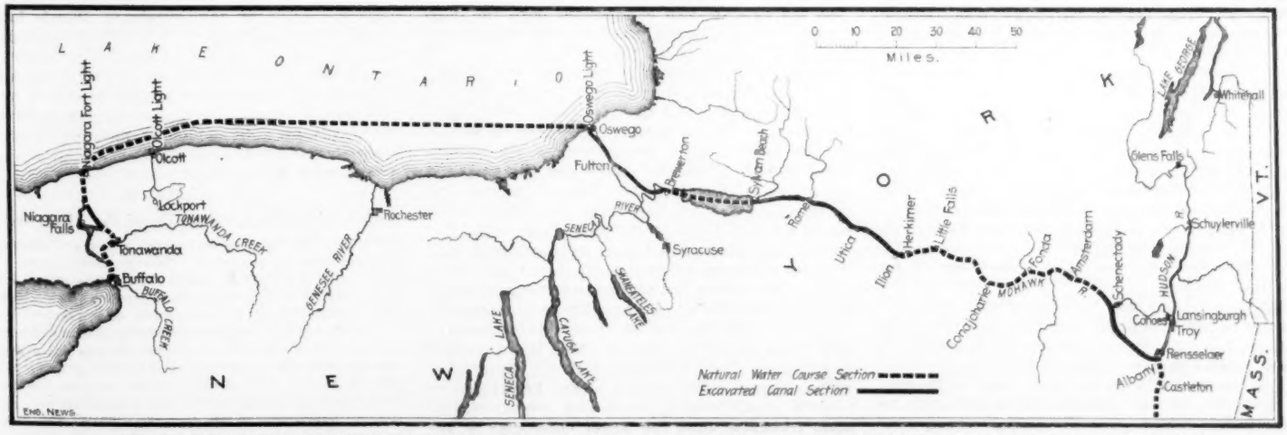


FIG. 2. MAP SHOWING GENERAL ROUTE OF PROPOSED 21-FT. DEEP WATERWAY FROM LAKE ERIE TO THE HUDSON.

The barge canal, on the other hand, is an artificial excavated channel for nearly its whole length.

The difference is of the greatest importance, not alone with respect to the cost of construction, but to the commercial usefulness of the two routes. A surprising result of the Deep Waterway Commission's surveys is that a waterway can be made from the Great Lakes to tidewater at New York city with only 100 miles of actual canal construction. All the rest of the distance of nearly 500 miles from Buffalo to New York a vessel will be sailing in open lakes or rivers.

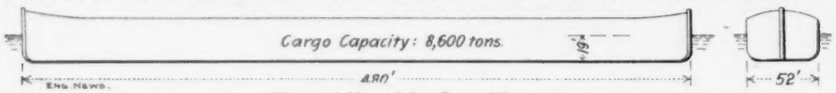
Another astonishing result of this use of natural channels, together with the very broad section of excavated canal shown in Fig. 1, is that vessels passing through the deep waterway will be able to make the voyage from Lake Erie to the sea in far less time than has ever been supposed to be possible.

*Report on Barge Canal Surveys, 1901, p. 612.

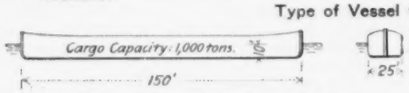
from New York up or down the coast to any of the New England ports or to those on the South Atlantic and Gulf coasts, to Cuba and the other islands of the West Indies and even to South America.

We are well aware that a part of the coterie which is pushing the barge-canal project in the New York legislature takes alarm at this point. As we have frequently pointed out, Buffalo stands ready to oppose any waterway big enough to let commerce pass her without paying tribute to her elevators and warehouses. New York starts with alarm at the idea that vessels might pass down the Hudson and out into the ocean without breaking bulk at her wharves.

With such narrow and local views of this enterprise we confess a lack of sympathy. If the public purse is to be opened to carry out any such great public work, then it ought to be made to work the broadest measure of public benefit. That the deep waterway offers a far larger measure of public benefit than the barge canal, no competent judge, who gives careful and unprejudiced study to the two projects, can deny. If a waterway enables the Lake commerce to go to the seaboard without breaking bulk, when the Buffalo elevator owners are exorbitant in their charges; and if it enables trade to be carried on direct between cities on the Lakes and cities on the Atlantic seaboard, these, we maintain, are strong points in its favor, as compared with a waterway which compels the transfer of all freight at each end.



Type of Vessel for Deep Waterway.



Type of Vessel for Barge Canal.

FIG. 3. SECTIONS OF TYPICAL VESSELS FOR THE BARGE CANAL AND FOR THE DEEP WATERWAY.

It need not be thought that Buffalo will be depopulated or that New York streets will become grass grown. The railways which connect the Lakes with the coast are still going to carry a large proportion of the traffic, we may be sure, no matter what waterway is built, and it is not to be forgotten that the canal will be out of service for five months of the year.

This brings us to another matter which is of enormous economic importance in comparing the relative merits of the barge canal and the deep waterway. This is that the deeper channel would give the vessels which ply on the Lakes access to the ocean at the close of Lake navigation each season.

Here is a great fleet of merchant vessels aggregating over a million tons which is now compelled to lie absolutely idle from November to April of each year. The opening of a deep waterway would enable these vessels to reach the seaboard and engage in coastwise and other commerce during the winter months. Can we overestimate the impetus which such an addition to transportation facilities would produce? Take for a single example the conditions of the present winter, when the available vessels for the carriage of coal from South Atlantic ports to New York and New England have been wholly inadequate to the demand, and when freight rates have been governed by this scarcity.

But here we are met by another well-worn argument of the opponents of the ship canal. It is that the Lake vessels are not seaworthy enough to stand ocean voyages. It is said even that it would not be economically profitable to add to the cost of the Lake vessels what would be necessary to make them safe for ocean navigation. It has even been claimed that the ocean vessel would cost double what the lake vessel costs per ton of carrying capacity.

When this argument was first brought forward, eight years or so ago, lake vessels were considerably smaller and lighter built than has since become the practice. At the present time, the expert of the Deep Waterway Commission estimates the cost of a lake vessel suitable for passage through the deep waterway and of the general dimensions shown in Fig. 3 at $360,000; and if built for ocean service as well, at $387,000. There can be no doubt that this additional cost or even a very much larger sum would be amply justified if by it the lake vessel could be enabled to engage in ocean traffic during the winter months instead of lying idle as it now does.

Of course, it may be said that the existing lake marine is not built for ocean traffic; but all the recently-built vessels are amply seaworthy at least for coastwise and Sound traffic, where harbors of refuge are always available in case of severe storms. Further, if the construction of a deep waterway were undertaken, several years would be required for its completion and shipbuilding on the Lakes would be done with a view to its future use. By the time such a waterway were completed, we may be sure, a large proportion of the then-existing lake vessels would be ready for ocean business during the winter months.

Another matter which deserves some attention in view of the prominence given to it in the New York legislature, is the possible competition of the St. Lawrence route to the sea. New York is in great fear lest Montreal shall rob her of her export trade. One governing motive in discarding the Lake Ontario route for the barge-canal project was the fear that commerce might continue down the St. Lawrence from Lake Ontario instead of going onward to New York.

Now, in so far as this is an argument, it strikes us as being against, and very strongly against, the barge-canal project. New York proposes to spend $80,000,000 or so to build a canal 12 ft. deep for vessels of 1,000 tons capacity; but Canada has already completed a waterway to the sea with 14 ft. depth all the way, in which vessels of 2,200 tons capacity can travel with ease. Further, for nearly its whole length, the Canadian route is not in canal at all, but in open lake and river navigation. So far as waterways from Lake Erie to tidewater are concerned, it looks to us as if the Canadian waterway now ready for business could give the New York barge canal cards and spades and still carry off the business. The real salvation of the New York route is the fact that Montreal is not at the ocean and that a thousand miles of dangerous and treacherous navigation of the Gulf of St. Lawrence remain to reach it.

So far as Canadian competition with the deep waterway is concerned, the best idea can be obtained by looking at the time-table, referred to in our article elsewhere. It is there seen that a lake vessel arriving at Oswego will be within 46 hours of New York city and the open ocean by passing through the deep waterway. It stands to reason that a vessel would not undertake the voyage down the St. Lawrence canals and the long and dangerous passage from Montreal to the ocean in preference. The marine insurance rates alone would compel choice of the New York route.

We might proceed at indefinite length with further comparisons of the barge canal and deep waterway projects, but limitations of space forbid. Nor should it be necessary with such a graphic comparison of the size of these two waterways and of the size of the vessels which it is proposed to use upon them as that which we show herewith. Anyone with even a slight knowledge of modern conditions of economic transportation must recognize that the larger enterprise is immeasurably the superior as an avenue of traffic.

Of course, if the barge canal were an enterprise of a moderate cost, it might possibly be worth while for New York to undertake it, purely for the local benefit to New York city and to Buffalo; although we must confess our grave doubts as to whether the benefits which will accrue to these cities from such a canal have not been largely overestimated. But the barge canal is not a small enterprise. We now know that it will cost nearly twice as much to build it as was originally supposed, and that its cost would be nearly half as much as the cost of the deep waterway with its vastly greater certainty of benefit. At the present day and with present knowledge, for New York to spend $80,000,000 on a barge canal, when so much more adequate a transportation route is within reach at so moderate an additional cost, would be nothing less than an economic crime.

But we hear the barge-canal advocates say that the United States would never undertake such a work. Those who take this position have reached it, we believe, through their narrow way of looking at every question solely with respect to New York's advantage. The fact is that the whole vast and wealthy territory tributary to the Great Lakes, extending from Montana and Dakota on the west to Kansas on the south, is quite as much interested in economic transportation from the Lakes to the Eastern markets and seaports as is New York herself.

When New York awakes to the advantage of having $200,000,000 of Government funds spent within its borders, when she realizes what it would mean to her factories and farms to have the greatest ship canal in the world passing from east to west across the state; when she understands what it would mean to have the commerce of the other Great Lakes extended to her cities bordering on Lake Ontario, and to the valleys of the Oswego, the Mohawk and the Hudson—when New York awakes to a large comprehension of her opportunities and takes the lead in National action looking to the construction of a National deep waterway, from the Lakes to the ocean, she will find plenty of support in Congress for the enterprise.

LETTERS TO THE EDITOR.

Derails as Automatic Stops.

Sir: I have been very much interested in the articles published in Engineering News on the Westfield Collision and anxiously waiting for some reply to the letter by "Mercy," in the issue of Feb. 5, on "What Shall Be Done for Absent-Minded Locomotive Engineers." I would like to know what you and "Mercy" think of placing a derail in connection with the home signal of each block.

It seems to me that if the engineer knew that he was sure to go into the ditch if he ran past a home signal set at danger, he would have his train under control regardless of all hindrances, steam, or anything else. Is it not the element of chance that causes, or allows, the engineer to run past signals set against him? He does not know what is ahead, hence runs his chances, but with the derail attached he would know what was ahead and would not disobey caution signals.

Yours very truly, L. T. Boyle.

Gulfport, Miss., Feb. 15, 1903.

(We would suggest that our correspondent consider the table of derailments at Illinois interlocked grade crossings on page 175 of our last issue. It will show him that a good many engineers do run past danger signals where they know a derailment will result. If an automatic stop is to be used with block signals, it should operate to apply the brakes, for a derailment at many points where block signals are located might be nearly as dangerous as a collision.—Ed.)

Needed Reforms in American Use of the Block System.

Sir: Your editorial "Some Lessons of Recent Collisions," has just come to my notice. To the question, why railroads using the block system in the United States are not operated with the almost absolute freedom from collisions which is secured in England, allow me to reply:

English railways operated under the block system have a signalman at the entrance of every section and so-called permissive blocking, common with us, is unknown. "Permissive blocking" is allowing trains to enter the block when the signal is against it and proceeding cautiously, nothing interfering, to the next clear block. This system is excusable under heavy freight traffic, but it deserves unqualified condemnation for passenger service.

The block system itself is no safeguard when enginemen will disregard signals and take chances, nor is it absolutely safe under the English system only that there stricter discipline prevails and the surety of detection in not complying with rules, makes better compliance. But even there, a signalman friendly to the driver may find it expedient not to report a breach of the rules. It becomes evident, that to make for greater safety the block system must be complemented with some automatic device which will control the train and register failure to obey signals. Derails are out of the question, as with trains going at high speed, they would mean loss of life and property.

Block signals with attachments for automatically applying train brakes are in use in the United States as well as in Germany and their more universal introduction would add another safety factor to railway operations.

However, it must not be forgotten that no machine can take the place of human intelligence; all automatic devices are liable to fail at a crucial time and it will always be the man behind the throttle on whom the main reliance for safety will depend. To impress upon him the importance of obeying signals can only be done by discipline. Disobedience to orders and signals should be ranked with the unforgivable "drunkenness."

Truly yours, G. W. Stadly,
Engr. M. of W., Algoma Central & Hudson Bay Ry. Co.
Sault Ste. Marie, Ont., Feb. 16, 1903.

Building an Embankment With Cars Running Over a Track Laid on Ice.

Sir: Engineering News within the past year has illustrated two methods of building embankments under some difficulty. I am at present building embankments by loading material with steam shovel into side-dump cars, and hauling to the site of the embankments with locomotives. It was necessary to carry the embankments across a slough about 500 ft. wide, in which was 3½ ft. of water, overlying a soft mud bottom. The finished embankment is to be 100 ft. wide on top and 14 ft. high above water level.

I inclose herewith some views (Figs. 1 and 2) showing method of extending the embankment across this slough, taking advantage of the fact that there was a foot or more of ice at the time. The railway track was laid on the ice, and short trains of loaded cars were brought down and dumped, three cars at a time, on either side, until a sufficient bank was raised to make the track safe for the locomotive. The cars were run 18 in a train, but six loaded cars only were brought to the front of the embankment at a time, the remaining loaded cars being left on a siding near by. It will be noticed that the ice sank under the load of the cars and earth, but as it sank the track was raised with crowbars and earth tramped under the ties. The work is in local charge of Mr. J. B. Bassett, Junior Engineer, and the photographs were taken by Mr. Fred. W. Honens, Junior Engineer.

Very respectfully yours, L. L. Wheeler,
Assistant Engineer.
Office of Assistant Engineer Illinois and Mississippi Canal, Sterling, Ill., Jan. 30, 1903.

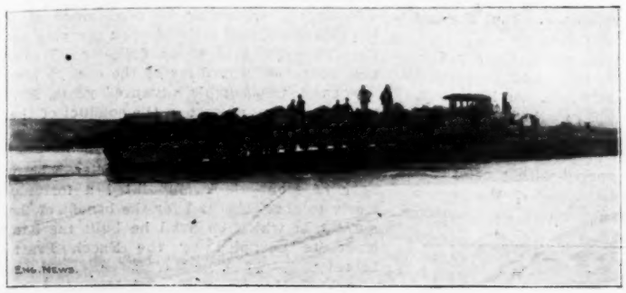


FIG. 1. BUILDING AN EMBANKMENT OVER A FROZEN SLOUGH.

FIG. 2. VIEW OF TRACK LAID ON THE ICE.

A Defense of Dynamite.

Sir: I notice in your issue of Jan. 22 two articles, one under the rather startling heading, "The Beginning of the End of Dynamite," and the other headed "A Safe and Economical Substitute for Dynamite," the same being a disquisition mainly about Jovite.

In the first-named article it is claimed that dynamite "rots," that is to say, that it is unstable, and becomes dangerous, and it is claimed that "more than this, the explosive part of dynamite is a liquid, nitro-glycerin, which is absorbed or soaked up by sawdust, wood pulp, or the like." And it is further stated that "So long as this liquid nitro-glycerin remains pure and remains 'soaked up' or absorbed there is little danger. It has been found, however, that the nitro-glycerin leaks under certain conditions. During thawing it frequently leaks out of the stick, or if it becomes wet the water causes the nitro-glycerin to leak out. In either case free liquid nitro-glycerin escapes, and in that free state it may be exploded by any very slight shock."

I have quoted the above from the said article. Now, as a matter of fact, no dynamite is being made to-day by any of the large concerns—for example, the Forcite Powder Manufacturing Co., the Atlantic Dynamite Co., or the Repauno Chemical Co.—in which there is any free nitro-glycerin. All first-class concerns now gelatinate the nitro-glycerin with soluble guncotton, and this jelly, and not "liquid nitro-glycerin," is mixed with the wood meal and nitrate of sodium.

Dynamite thus made is very insensitive to all forms of shock likely to be encountered in handling and transport and in use. When handled without criminal carelessness it is practically as safe to ship as sand. The instance mentioned in the article in your paper, where a carload of dynamite exploded on the Delaware & Lackawanna Railroad, is an instance where the dynamite was not at fault, and although a carload of Jovite might not have exploded under the circumstances, still an explosion would not have been at all unlikely, even of that compound.

I am not engaged at the present time in the manufacture of dynamite, and my interest in this matter is simply to correct any misapprehension which the said article may give rise to in the mind of the public as to the actual facts in the case.

In regard to the number of people killed and injured in thawing dynamite, this is a bugbear that has been made much of by those who have been exploiting the so-called "safety" explosives.

I conducted a good many experiments at one time to produce a dynamite which could be exploded without thawing, and this I accomplished by the simple expedient of putting into the dynamite about 10% of its weight of fibrous, insoluble guncotton. Although this dynamite could be fired even when frozen hard, it was found that the same quantity of dynamite, fired frozen, gave results far inferior to those given when fired warm, and that, for economy alone, it is better to warm the dynamite in winter before firing it, for the difference in temperature results in difference in effects which would require an additional percentage of at least 10% of nitro-glycerin to make good. Thus, a 40% dynamite fired warm will give results equal to a 50% dynamite fired frozen or at a temperature below the freezing point of water, or even below the freezing point of nitro-glycerin, that is to say, below 40° F.

Now, it is my opinion that dynamite is not going to be replaced in a hurry by any other high explosive whatsoever for ordinary blasting purposes, and the following are my reasons:

Nitro-glycerin is made by nitrating a cheap by-product, that is to say, glycerin, a by-product produced in enormous quantities in soap factories, and a product which owes its present price to its large consumption by dynamite manufacturers. Still, at the price, anywhere from 11 to 16 cts. a pound for the raw glycerin, it is quite impossible to produce any compound which will equal it in energy at an equal cost. Now, nitro-naphthalin represents of itself an explosive energy, when combined with an oxidizing agent, about equal to black gunpowder, that is to say, about an eighth part of the energy represented by an equal weight of nitro-glycerin. Although nitro-naphthalin cannot well be detonated by itself, still, if detonated in a strong steel cylinder by a very powerful exploder, its products of combustion contain about 56% solid matter, that is to say, precipitated carbon, and 44% gaseous products, while the amount of heat evolved is far inferior to that evolved by black gunpowder, yet when combined with nitrate of soda this is compensated for.

Picric acid costs, at the present time, from 22 to 25 cts. a lb. Last year it cost 35 cts. per lb. on account of the Boer war. Now, as the quantity of nitrate of sodium would be about equal in Jovite and in ordinary dynamite, and as wood meal is much cheaper than nitro-naphthalin, which latter costs from 11 to 12 cts. per lb., and as nitro-glycerin does not cost more than about half as much as picric acid per lb., dynamite has certainly the advantage as to cost.

Again, were Jovite to come into general use in place of ordinary dynamite, the price of picric acid would advance and that of glycerin would fall, and there would be a still greater difference in cost in favor of dynamite.

Picric acid is made from nitrating carbolic acid, and there is not carbolic acid enough made in the United States to furnish 5% of the picric acid which would be required to replace the quantity of dynamite now in use.

There is but one concern in the country which makes picric acid at the present time, and this concern makes it synthetically from benzole. The amount of benzole depends upon the amount of coking done, the benzole being recovered from the gases. The cost of benzole, although cheap, cannot compensate for the additional cost of converting it into picric acid, the expense of which production can never fall much below 20 cts. per lb., while nitro-glycerin could certainly be made for half that cost were the price of glycerin to be a little lower than it is at the present time, and which would result from the introduction of a competing explosive—I mean one which would seriously compete.

There is another advantage which dynamite has, which must not be overlooked. It is in the form of a paste, it is plastic and yielding, and as at present made with the crystals of nitrate of soda agglutinated and coated with nitro-gelatin, it is quite non-hygroscopic—much more so than Jovite.

Without disputing the highly stable character of Jovite, we must not admit that dynamite when properly made, and as now being made by the large concerns I have already mentioned, is less stable than Jovite. At any rate, I know of dynamite now in storage made more than ten years ago, which has undergone no change whatever.

Now, in regard to fumes, I note what is said in favor of Jovite, that its fumes are not noxious, while those of ordinary dynamite are claimed to be. The products of combustion of either dynamite or Jovite must necessarily both be noxious. Both must contain a large percentage of carbonic oxide—a most deadly gas—while carbonic acid and aqueous vapor and free nitrogen, the other gaseous products of combustion, cannot be claimed as adapted to support life. They cannot be recommended for respiration.

Yours truly, "Dynamite."
New York City, Jan. 29, 1903.

[Regarding the deleterious fumes from dynamite it should be observed that the best authorities attribute the poisonous effects not to the products of combustion, but to the vaporized and unburned nitro-glycerin. Handling sticks of dynamite will in itself produce headaches and nausea in the case of men unaccustomed to its use, due to the nitro-glycerin absorbed by the skin. Exactly similar effects follow the inhaling of dynamite fumes after explosion. In accordance with our custom of publishing a reply following a criticism, a proof of the foregoing letter was submitted to the Explosives Manufacturing Co. Their reply follows:—Ed.]

Sir: The communication signed "Dynamite," which we have been permitted to read, suggests the following:

It cannot be denied that even the best and higher-priced gelatin dynamites, under certain conditions often present in actual use, will "leak" nitro-glycerin. Furthermore, all dynamites will freeze and the necessary thawing process has a tendency to cause leaking of the nitro-glycerin, to which process is attributable a large percentage of all accidents resulting from the use of explosives. Whether or not this last statement is a "bugbear" can be best judged by examining the statistics of dynamite accidents. A non-freezing explosive which contains no nitro-glycerin accordingly has, by virtue of these facts alone, two important elements of safety.

It seems to be admitted by the article in question that Joveite is safer than dynamite, the major part of the article being devoted to showing that the manufacturing cost of Joveite, a typical safety explosive, is greater than that of dynamite. The manufacturers of safety explosives take the broad ground that for certain classes of work safety explosives should be used in place of dynamite, even at a higher selling price. The public is evidently not especially concerned with the nature of the explosive used for shooting oil wells or in many blasting operations which are carried on at a distance from centers of population; but since the Park Ave. explosion it seems superfluous to argue that as regards blasting carried on within city limits, which may at any moment entail great loss of life and property, the public is very vitally interested in the kind of explosive used. If the only argument against safety explosives is one of cost it remains to present the question squarely to the public and see whether it considers its safety worth less than the slight additional cost, if any, of these explosives.

The present consumers of safety explosives are perhaps the best judges as to whether Joveite, as one type of these explosives, has a legitimate field. If they continue to use it in preference to dynamite, a fair assumption

would be either that it is at least as cheap as dynamite, judged by actual efficiency, or else that its safety properties make it so much more desirable that the additional price is immaterial. Very truly yours,

The Explosives Manufacturing Co.

Elmira, N. Y., Feb. 14, 1903.

Notes and Queries.

In the supplement to our last issue an error occurred in the notice of a circular issued by the Plunger Elevator Co. We stated that some of the installations made by this company employed car speeds up to 200 ft. per minute. The correct statement, as made in the circular itself, is "recent installations include elevators of over 200 ft. travel and speeds of from 500 to 600 ft. per minute."

S. T. G. writes:

I should like to see in your columns, or to be informed where I may find, a statement of the manner in which piles are pulled and how much in this line may be expected from a comparatively small land driver. What are, may I also ask, some of "the tricks of the trade?"

I had occasion recently to order pulled a pile which had been driven but a few feet, in very hard driving however. The foreman, after some minutes' work, informed me that he couldn't budge it and, indeed, he had not. I watched the entire process carefully, but could discover no "trick." Had I demanded too much or had I been fooled, is a question which I have asked myself since.

NOTES FROM THE ENGINEERING SCHOOLS.

HARVARD UNIVERSITY.—A "Charles Eliot" professorship of landscape architecture has just been established. The late Charles Eliot, Landscape Architect, was a son of President Eliot.

CLARKSON SCHOOL OF TECHNOLOGY.—Mr. Merrill Van G. Smith has been appointed Associate Professor of Mechanical Engineering, to fill the chair made vacant by the resignation of Prof. Robinson last November. Mr. Smith graduated in 1896 from Stevens Institute of Technology.

PURDUE UNIVERSITY.—The annual trip of inspection by junior students in Engineering will begin April 15 and end April 18. This trip, as for several years past, will be made to Chicago, where the headquarters will be the Victoria Hotel. About 200 students will make the trip.

That the purpose of the trip may be made effective, three separate parties will be formed, made up as follows: Representatives of the School of Civil Engineering, under the direction of Professor Pence; representatives of the School of Electrical Engineering, under the direction of Professor Matthews; and representatives of the School of Mechanical Engineering, under the direction of Professor Hoffman. These various parties will visit structures and works of greatest interest to each class of engineers.

SCHOOL OF PRACTICAL SCIENCE.—At the annual dinner of the students of this institution, held in Toronto on Nov. 28 last, an address was delivered by Mr. W. T. Jennings, M. Am. Soc. C. E., chairman of the Board of Examiners in Engineering, Toronto University. The following are extracts:

Of all the professions that of an engineer calls for the highest standard of honesty in word and deed. His sense of honor and right should be of the highest order, and he should be able to say "no" emphatically to all schemes of a doubtful character.

To his client he must be thoroughly loyal. To his fellow practitioners he should display brotherly love.

In the matter of monetary compensation it too frequently happens that the return for faithful and successful service is far below a just sum, and this result is largely attributable to the engineers who, in many cases, allow themselves to be led away by "promises" or by the fear of losing a fee on a contemplated work which they think will be a lasting advertisement.

Thus do they depreciate their professional value and importance in the minds of clients, be they individuals or companies, and until these conditions change, by the united practice of a recognized code, the civil engineer will not be accorded his just standing.

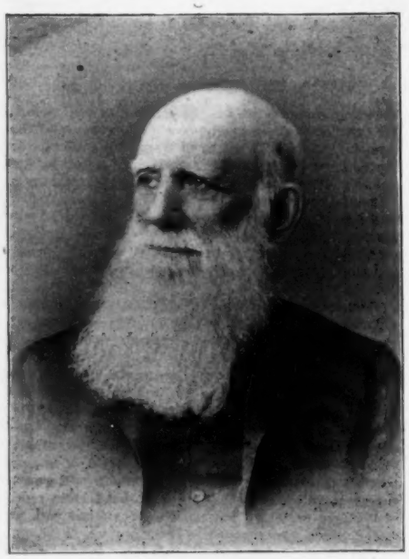
COLORADO COLLEGE.—The trustees of Colorado College, in Colorado Springs, Colo., at the request of the President and the Faculty, decided last December to establish a School of Engineering. A new science building is now being erected at a cost of $270,000. A shop for machine and woodwork will be begun at once. The two structures will be completed before the opening of the coming school year, and will be used by the new School of Engineering. It is the plan to offer next year only the work of the first and second years, and add the third year in 1904-1905, and the fourth year in 1905-1906. Courses will be offered in mining, electrical, civil and irrigation engineering. The faculty and the equipment will be increased with the growth of the school. Prof. Florian Cajori, Ph. D., has been made dean. Dr. Cajori is the well-known author of "The Teaching and History of Mathematics in the United States," 1890; "A History of Mathematics," 1894; "A History of Elementary Mathematics," 1896; and "A History of Physics in its Elementary Branches," 1899.

Colorado College is exceptionally well situated for technological work on account of its proximity to the reduction works of Colorado City, the gold mines of Cripple Creek, the manufactories of Pueblo, and several mountain railways.

ROBERT POOLE.

In the death of Robert Poole, of Baltimore, on Jan. 14, the engineering profession loses another of its pioneers who did notable and useful work in the period of active development about the middle of the last century.

Mr. Poole was born in Maghera, County Londonderry, Ireland, May 26, 1818, and he came to the United States at an early age. As he was the sole support of a widowed mother and of a younger brother and sister, he was forced at once to seek employment, and he obtained a position in the machine shops connected with the Lanvale Cotton Mills, located near the site of the present Union Station, in Baltimore, where his industry



Robert Poole.

and desire to learn secured for him many advantages and he rapidly secured a knowledge of his trade. A change in the ownership of the mills, however, necessitated his removal to Savage, Md., where he was employed for some time in the making of cotton-mill machinery of English design. From there he went to the works of the famous Ross Winans, then busily employed in building locomotives for the Russian government and for American railways.

About 1841 Mr. Poole concluded to start in business for himself, and with a small upright engine, built from his own patterns, he fitted up a modest machine shop on Holliday St., in Baltimore. He was burned out a few days later, but he patched up his engine and commenced again. His pluck and energy attracted the attention of some men wanting machinery, and they gave him their orders, and as business increased he formed a partnership with William Ferguson, a Scotchman, and this firm lasted until July, 1851, when Mr. Poole bought out the interest of Mr. Ferguson and formed a new partnership with German H. Hunt, under the firm name of Poole & Hunt, and this firm continued in business for nearly forty years. Mr. Hunt withdrew in 1889, and the business was then incorporated under the name of the Robert Poole & Son Co.

Shortly after the firm of Poole & Hunt had been established their shops were burned out, and the growing business was removed to Woodberry, then a small village a few miles north of Baltimore. Here extensive workshops were built, primarily for the manufacture of locomotives, but the financial depression of 1853 so seriously affected the railway interests that the attention of the firm was directed into other lines, and the present extensive engineering plant was gradually developed.

Mr. Poole, early in his career, was recognized as a mechanic of more than ordinary ability and judgment. He was among the first to recognize the necessity for a higher standard of accuracy in measurement in shop work than then prevailed, and early in the 60's his firm imported a set of Whitworth gages, and his establishment was one of the first in this country to inaugurate the shop system of gages and standards now recognized as essential in all first-class manufacturing plants.

From the beginning he condemned all faulty workmanship, and insisted upon carrying out with the greatest exactness the fullest requirements of his contracts, regardless of the cost to himself.

Notwithstanding his advanced years, Mr. Poole took an active interest in the conduct of the business which bore his name up to the very week of his death at the age of 85.

He was a good judge of character, a born manager of men. He accumulated a fortune, gave freely to charities, and for the benefit of the community in which he lived he built the handsome structure occupied by the Enoch Pratt Free Library.

In 1841 Mr. Poole married Miss Ann Simpson, and five daughters and one son survive him. Mr. George Poole, his son, has been the active head of the business for years, and continues in its management.

REPORT ON THE ESTABLISHMENT OF A STATE ELECTRICAL LABORATORY IN NEW YORK.

The Legislature of New York passed a bill last year creating a commission of engineers to consider the advisability of establishing a "State electrical laboratory to provide independent, authoritative information on questions of electrical science, and an official standardizing laboratory . . . ." Messrs. E. A. Bond, State Engineer, Charles P. Steinmetz, and Harold W. Buck were selected to constitute this commission. Their report has just been submitted to the Legislature. The report recommends that such a laboratory be established and submits plans and estimates as to the buildings and equipment.

In arriving at a decision the commission prepared a list of various matters upon which question arises or might arise in connection with electrical work. This list of possible matters of question or dispute was submitted to a large number of persons prominently connected with electrical engineering, with the suggestion that a State electrical laboratory would offer a means of deciding or avoiding these difficulties, or of providing authoritative information of an unbiased character. An opinion was requested on this point and also on the matter of the scope, etc., of the proposed laboratory. The replies received represented many different points of view; but the majority heartily favored the idea of establishing a State laboratory as outlined.

Guided in part by these replies, the commission expresses itself strongly in favor of such a laboratory, and proceeds to discuss its scope. The functions of the proposed laboratory are stated as follows:

(1) The calibration of all forms of electrical meters and other electrical apparatus and appliances.

(2) Experimental tests which may be called for by the courts, by municipalities, or by individuals, for impartial evidence on disputed questions of fact.

(3) Continual investigation and experiment with a view to the development of electrical science and the further application of electrical power to useful ends.

In the opinion of the commission these purposes are of such importance to the people of the state as to justify the immediate establishment of the laboratory upon the lines proposed in this report.

The field of work included under (1) will be readily apparent. As to the work included under (2), it may be remarked that the report speaks in not the most glowing terms of expert testimony: "Experience has shown that almost any desired testimony can be secured by those who are willing to pay for it; and while this does not

disparage the honesty of every man called as an expert witness, it does tend to discredit the impartiality of expert testimony as a whole." This utterance is made, not about medical, but about engineering testimony! The laboratory then is intended to supply either expert testimony or the experimental basis therefor, of a character beyond question, and at moderate cost. In regard to heading (3), the report explains that "what the State essays to do for the science of agriculture and forestry and veterinary surgery may well be undertaken for the science of electricity," and asserts "that the public service which a State laboratory can render in the direction of further investigation and experiment is beyond question and justifies its establishment apart from all other considerations."

The plans for the laboratory comprise five buildings, a power house, 62 × 102 ft.; a storage building, 42 × 62 ft. (two-story); an electrochemical building, 42 × 102 ft. (two-story); a machinery building, 38 × 102 ft.; and an administration and instrument building, 53 × 103 ft. (three-story). The total estimated cost for the laboratory complete is $275,000, of which $81,949 is for buildings, $182,500 for equipment, and $10,551 for superintendence, contingencies and architectural treatment.

STREET TRAFFIC IN LONDON is to be studied by a Royal Commission. The work of the commission, according to the London "Surveyor," will be as follows:

It will inquire, in the first place, into the possibilities of improvement (1) by the development and interconnection of railways and tramways on or below the surface; (2) by increasing the facilities for other forms of mechanical locomotion; and (3) by better provision for the organization and regulation of vehicular and pedestrian traffic, or otherwise. In the second place, the commission will report as to the desirability of establishing some authority or tribunal to which all schemes of railway or tramway construction of a local character should be referred, and the powers which such a body should possess.

A DEEP WATERWAY FROM THE LAKES TO THE ATLANTIC.

In the current discussion in the New York legislature over the 1,000-ton barge canal project, references all the time appear to the proposed United States deep waterway from the Lakes to the ocean. There is, in fact, a considerable party in the legislature which opposes the barge-canal proposition and favors instead the construction by the United States of a ship canal connection from the Lakes to the Hudson. Unfortunately, the public and the members of the legislature appear to have little knowledge concerning this ship-canal project. It seems to be even unknown to many that the entire route has been carefully surveyed and estimated and has been the subject of as complete and thorough an engineering investigation as has ever been made, perhaps, for any public work in this country. The results of this investigation, however, have never been spread before the public. They were put on record, indeed, in the three huge volumes of the official report; but they have been barely mentioned in the newspapers and have received little more attention in technical journals.

For this reason we have deemed it appropriate at this time to present a brief description of this proposed ship canal, believing that knowledge concerning it is essential to a fair judgment of the rival 1,000-ton barge canal project now under consideration in New York.

Agitation for a ship canal or deep waterway from the Lakes to the ocean has been going on since the '70's, and in the early '90's the interest in it became such that conventions were held in the Lake cities to further the project. This led to the appointment, by President Cleveland in 1895, of an International Commission to investigate the project and report upon it. The United States members of this commission were President Jos. B. Angell, of Michigan University; Lyman E. Cooley, C. E., of Chicago, and Hon. John E. Russell, of Massachusetts. This commission had only sufficient funds to make a few rough reconnoissance surveys; but in its report it affirmed the feasibility of the ship-canal project and advised that detailed surveys be made.

In 1897, Congress made provision for such surveys and President McKinley appointed Major Chas. W. Raymond, Corps of Engineers, U. S. A., and Messrs. Alfred Noble and Geo. Y. Wisner, Members of the American Society of Civil Engineers, as a commission to conduct such surveys. Three years' time and $485,000 of money were spent in this work, and the commission's report, presented in 1900, gives complete information upon the project in every detail.

Previous to this commission's investigation all sorts of opinions were held concerning the ship canal—or deep waterway—scheme, and the data were lacking on which to base any intelligent opinion. None could say certainly whether such a canal were practicable as an engineering proposition or not; whether, if built, ships would use it; whether it should be made deep enough to float the largest class of ocean-going vessels, or only deep enough for the vessels of the Great Lakes, or whether a canal for large barges—such as New York has now under discussion—would not answer every purpose. The matter of route was also a matter of speculation. Some favored the route via the St. Lawrence River and Lake Champlain; some, that by Lake Ontario and the Oswego and Mohawk rivers; some the route of the present Erie Canal.

All these matters and many others which have been in controversy were given the fullest expert investigation by the commission and its conclusions are entitled to the weight of authority.

No man to-day is competent to discuss intelligently the subject of water routes from the Lakes to the Atlantic unless he has studied the Deep Waterway Commission's report; and whoever takes a position opposite to the conclusions expressed in this report deserves no credence unless he presents his grounds for dissent from these conclusions.

First and most important is the matter of depth. The commission made complete surveys and estimates for two channels, the one a waterway of 21 ft. depth, which would give passage to all the vessels now navigating the Great Lakes and to the great bulk of the merchant marine on the ocean as well, the other a channel 30 ft. in depth, large enough for practically all the vessels afloat on the ocean which are operated under traffic conditions that would permit them to use such a canal.

The result of this estimate showed that the 30-ft. channel would cost at least $125,000,000 more than the 21-ft. channel and offered no commercial advantages at all proportionate to this excess of cost. The larger waterway would be of smaller traffic capacity than the 21-ft. channel on account of the difference of time spent in lockage, and this factor also about neutralizes the higher speed which smaller vessels could make in the larger waterway in the reaches between locks. The fact that all the Lake harbors and channels, as well as the docks, piers, etc., are designed for the vessels of moderate draft now navigating the Lakes, is another fact showing the inferiority of the 30-ft. channel as a commercial proposition to the channel of 21 ft. depth.

Turning now to the matter of route, complete surveys and estimates were made for waterways by the St. Lawrence and Lake Champlain route and also by the route across the state of New York from Lake Ontario via the Oswego and Mohawk rivers. The route from Lake Erie direct to the Hudson was not surveyed as it is well known to be only feasible for a barge canal. A waterway of even 21 ft. depth by this route would be so enormously expensive and involve such engineering difficulties as would make it impracticable.

These careful surveys and estimates fully establish the superiority of the route via Lake Ontario and the Oswego and Mohawk rivers. While the cost of building a canal by the Champlain route is a little less, the much greater distance, the shorter season of navigation and other conditions prove the Oswego-Mohawk route to be the preferable one.

This route, beginning at Buffalo, follows down the Niagara River to Lasalle, 15 miles. Here the canal proper begins and continues for about 10 miles to the Niagara escarpment, which is descended by a series of locks to the lower level of the Niagara River below the gorge. There are nine locks in all between the level of Lake Erie and that of Lake Ontario, the difference of elevation being 330 ft.

Leaving the lowest lock of the series, a vessel would enter the lower Niagara River, which is deep enough and wide enough for any ship afloat, and it follows down the river—which is really an arm of Lake Ontario—till it debouches into the Lake, six miles below. Thence the vessel proceeds through Lake Ontario to Oswego, distant about 100 miles from the mouth of the Niagara River.

From Oswego the route is up the valley of the Oswego River, partly in an excavated channel, to the village of Fulton, where it turns up the valley of a small creek and continues across sand ridges to Oneida Lake. The total distance from Lake Ontario to Lake Oneida is about 26 miles. The vessel then passes through Lake Oneida, a distance of about 21 miles, and then enters the longest section of excavated canal encountered, that from Lake Oneida to the Mohawk River at Herkimer, N. Y., a distance of 43 miles. From Herkimer to near Rotterdam Junction, 55 miles, the Mohawk River is to be used, being converted by dams and locks into a system of slack-water navigation. Over a large part of this distance the vessel will be in a channel of such depths and width that she can make as good time as on the open lake. At Rotterdam Junction, the route leaves the Mohawk and passes through South Schenectady to the head of a small stream known as Norman's Kill. It follows the valley of this stream to the Hudson. Below this point about $4,000,000 will have to be spent on the Hudson River from the mouth of Norman's Kill to Hudson City to secure a 21-ft. channel.

So much for the general route to be followed. The particular feature of this route which most deserves attention is that it is a utilization of natural waterways and not an artificial channel. Of the total distance from Buffalo to New York (477 miles) only 102 miles are in standard canal section, and 98 miles are in canalized rivers from 250 to 1,000 ft. in width. The remaining 277 miles are in open lakes and rivers where a vessel can make nearly or quite as good time as she can on the open waters of Lake Erie or Lake Huron.

This, taken in connection with the liberal size adopted for the canal section will enable vessels to make a very high speed on this route. The estimates have been worked out with the greatest care, from the known time occupied by vessels in passing the Sault Lock and the St. Clair Canal, checking them by the most thorough investigation of all available data of the speed of vessels in existing ship canals. The result shows that a vessel of 11,700 tons displacement and 8,600 tons cargo capacity would take only 64 hours to make the passage from Buffalo to New York city, 477 miles. About 7 hours are required for the passage from Buffalo through the Niagara River and down the flight of locks to Lake Ontario; 11 hours more through the open waters of Lake Ontario bring the vessel to Oswego. About 17 hours are then required for the passage up the Oswego valley and through the long canal section to the pools of the Mohawk River (of which about 2 hours are spent in traversing the open waters of Lake Oneida). Then 9½ hours are required for the passage down the Mohawk Valley, 8 hours for the passage from there to the Hudson and 12 hours for the run down the Hudson to New York.

The total estimated cost of constructing the 21-ft. waterway from Buffalo to New York, is in round numbers $200,000,000 ($199,400,000). Of this total about $42,000,000 is the cost of the division from Lake Erie to Lake Ontario, and the balance the cost from Lake Ontario to deep water in the Hudson River. Again, of the total cost of $200,000,000, almost exactly half is for the item of excavation; locks cost $36,000,000; right of way $12,500,000, and retaining walls, slope walls and back filling, $11,000,000. An allowance of 10% for engineering, superintendence and contingencies was made on all items.

The proposed canal, a cross-section of which is shown on another page of this issue, is to have a bottom width of 240 ft. in rock and of 215 ft. in earth, and the width is increased on curves. The section was designed after careful studies of experience on the St. Clair Flats Canal and the Suez,

Manchester, Amsterdam and Kiel ship canals to permit a speed of 8 miles per hour on tangents without danger to passing ships or damage to canal banks. On open rivers where the channel banks are not defined, a bottom width of 600 ft has been adopted for safe navigation. The depth of 21 ft., it may be stated, is designed to leave a depth of 2 ft. under the keel of loaded vessels, and will permit the passage of any vessels navigating the Great Lakes, for none of the Lake harbors have now over 20 ft. depth of water, and many have only 16 to 19 ft.

The locks are to be each 600 ft. long, 60 ft. wide and with lifts varying according to topographical conditions. The locks at the Niagara escarpment have a lift of 40 ft. each. Where flights of locks are used, the locks are in duplicate throughout. The lock-gates are to be steel double-leaf miter gates with horizontal girder frames.

The annual cost of maintenance and operation of the waterway is estimated by the commission at $2,343,478, which, it may be parenthetically remarked, is not so very much more than the State of New York now pays to maintain the old Erie Canal. The maximum annual traffic capacity is estimated at 36,608,000 tons, when all the locks are made in duplicate. The probable traffic is not likely to exceed 10,000,000 to 20,000,000 tons. It may be noted that the speed provided would make quicker passage for freight from Chicago or Duluth to New York than is now attained by railway freight in passing between these terminals.

In an editorial in this issue we have discussed at length the relative merits of this projected enterprise and of the proposed 12-ft. barge canal, now before the New York legislature.

THE PROPOSED EXTENSIONS OF THE NEW YORK RAPID TRANSIT RAILWAY SYSTEM.

The extension and improvement of the Rapid Transit subway and of the Manhattan elevated railway lines are planned by the Board of Rapid Transit Railway Commissioners, and at the regular meeting of the commissioners on Feb. 19, their chief engineer, Mr. Wm. Barclay Parsons, M. Am Soc. C. E., presented a report outlining the general plans of the proposed work. This report is a document of some length and enters in considerable detail into general considerations of traffic and other questions connected with the proposed work. The following extracts will however serve to explain the work to be done and to present the reasons for it in each case:

RAPID TRANSIT SUBWAY EXTENSIONS.—When the bids for the Brooklyn extension were opened it will be recollected that Mr. Belmont, as president of the Rapid Transit Subway Construction Co., offered to build a line from 42d St. to 14th St. at considerably below the estimated cost. Such a line would, however, but transfer the point of congestion from 42d St. to 14th St., and I therefore propose that this line be extended to the lower end of Manhattan Island at South Ferry, following University Place, Wooster and Church Sts., and thus furnish two additional tracks south of the Post Office.

From this line at Broadway a subway under 32d St. to Seventh Ave. should be built so as to bring the new Pennsylvania terminus to a connection with the subway and elevated railway for the purpose of local distribution of passengers.

In like manner I propose to make a junction, as our general plan originally contemplated, at about 40th St. and Park Ave., and carry the new line with three tracks beneath the Grand Central Station to Lexington Ave., and then along and under that thoroughfare to The Bronx, making a connection with the New York Central & Hudson River and the New York, New Haven & Hartford railroads at Mott Haven.

Although the line passes beneath the yard of the New York Central between 42d and 45th Sts., property not subject to condemnation, nevertheless, I believe that satisfactory arrangements can be made for the easement. A branch from this line can be carried westward under 110th St. to Lenox Ave., thus providing a connection between the east and west lines north of Central Park, as the 42d St. subway line provides one south of the Park.

On the extreme easterly end the line in The Bronx should be extended from West Farms along the east side of Bronx Park, unless the Park authorities prefer a direct route through the park in order to reach Wakefield and Mount Vernon, two rapidly growing sections of the city now without rapid transit facilities. A branch should also be laid out continuing along the Southern Boulevard and then westerly on 180th St., thus reaching a section of The Bronx not served by any line. A connection between the Bronx Park line and the Manhattan elevated should also be made from Brook Ave. along Westchester Ave. to Third Ave.

MANHATTAN ELEVATED EXTENSIONS.—The additional lines, and especially those in subway, will require some years to complete, and during this time it is absolutely essential that immediate relief measures be provided. For reasons not necessary to discuss the Manhattan Elevated Ry. Co. has never accepted former suggestions of the Board to provide such additional facilities as the Board deemed advisable. Recently, however, the management of this property has passed under the control of the Interborough Rapid Transit Co., and I am informed by Mr. Belmont that he will gladly and liberally meet the views of the Board and extend the Manhattan lines, and so connect them with the subway system that both systems may be operated as a unit with through trains at a single fare. Such an arrangement would at once confer a great benefit upon the local traveling public, as presenting the quickest means of securing immediate relief. To this end I suggest the following alterations in the Manhattan structure and method of operation:

Second Ave. Division: Add two tracks from the Harlem River to Chatham Square, carrying the two new tracks over the Chatham Square junction and over the Park Row line to City Hall.

Third Ave. Division: Extend the third track from 59th St. to Ninth St., so as to make it continuous from the Harlem River to the latter point.

Suburban Division: Add a third track from south of the Harlem River to Westchester Ave.

Sixth Ave. Division: I would propose an extension along Christopher St. to Greenwich St., connecting with the Sixth Ave. division at the north end of the Eighth St. station, and thence lay a third track on the Sixth Ave. structure northward.

Ninth Ave. Division: I recommend: (1) The extension of the third track from 14th St. south to Cortlandt St., so that the express service may begin from the latter point. (2) A branch from the main structure at 53d St., running westerly along 53d St. to 10th Ave., northerly along 10th Ave. to 55th St., where, owing to the topography, the elevated structure can be depressed into subway and so carried under Amsterdam Ave. to a connection with the subway at 72d St. (3) The extension of the third track from 116th St. north to 155th St., making a continuous third track from Cortlandt St. to the Harlem River. (4) Make an arrangement with the Putnam Division of the New York Central & Hudson River R. R. by which the present bridge across the Harlem River can be reconstructed into a three-track structure, and then extend the Eighth Ave. line across the Harlem River with three tracks and by a short tunnel through the high ground on the east bank of the Harlem River to Jerome Ave., thence northerly along Jerome Ave. to Woodlawn, and thence westerly in the neighborhood of Mosholu Ave. to a connection with the Putnam Division in Van Cortlandt Park.

STEAM RAILWAY CONNECTIONS.—If the consent of the railroads with terminals at 42d St. can be had, connections should be made at as many points as possible with the subway and elevated lines. The points where such connections can be made are with the suburban elevated at Fordham; with the proposed Jerome Ave. extension at Van Cortlandt Park; with the subway at Kingsbridge; with the Manhattan elevated at 155th St., to both the main line and the Putnam Division of the New York Central; with the subway to the New York Central at the Harlem Ship Canal; with the Lexington Ave. subway to the New York Central, Harlem and New York & New Haven railroads at Mott Haven; and all so arranged that local trains from nearby suburban points can be run direct over the rapid transit lines and thus avoid the congestion at the Grand Central Station or the delay in transferring from one railway to another..

In addition to this, however, the New York Central now owns the railway along its own right of way from Spuyten Duyvil to 59th St., and thence on the surface of 11th, 10th and other avenues and streets south to Houston and Beach Sts. This line might easily be converted into a passenger line and furnish a great measure of rapid transit relief. The existence of the tracks on the street surface south of 59th St. is a great public burden, and should be removed if possible.

I would suggest that negotiations be taken up with this company looking to the removal of these surface tracks, and substituting in place thereof an elevated structure along the same route, or possibly along West St., and which, if constructed so far south to Battery Place, and so provide not only a freight, but also a passenger line along the water front. If this were done, the line should be constructed with four tracks south of 59th St., with the passenger tracks elevated above that point.

I suggest that a branch of the Second Ave. elevated be constructed along 64th St. and over the Blackwell's Island bridge to Long Island, and that a plaza be then arranged, permitting the present surface lines now plying throughout that district to approach and deliver their passengers to the elevated, by which they can be carried by an express and local service to any point north or south in Manhattan, Brooklyn or Bronx.

COST OF IMPROVEMENTS.—If the Board should carry out these suggestions, the city will own a railway system complete in itself, covering 37½ miles in the boroughs of Manhattan and The Bronx, with 100 miles of track, exclusive of side tracks. On the other hand, the plan proposes to afford the greatest measure of immediate relief by the only way in which such relief can be afforded; that is, by the expansion of existing facilities. Such expansion would be obtained by the use of private capital, without encroaching on the debt-incurring capacity of the city, but under such proper terms as would be laid down by the Board. The equivalent amount of single track above mentioned is about 130 miles, and the expense of construction, liberally estimated, is between $45,000,000 and $50,000,000, about one-half of which will fall on the city.

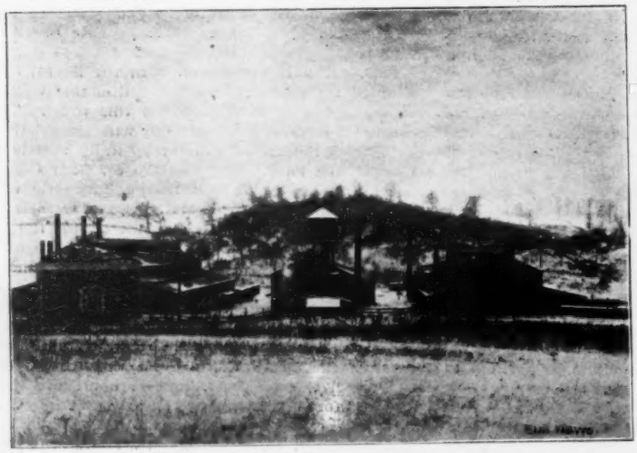


FIG. 1. THE NEW PLANT OF THE JESSOP STEEL CO., AT WASHINGTON, PA.

FIG. 3. VIEW IN THE ROLLING MILL; JESSOP STEEL WORKS.

THE NEW PLANT OF THE JESSOP STEEL CO. AT WASHINGTON, PA.

By H. G. Manning, M. E., M. Am. Soc. M. E.*

The new plant of the Jessop Steel Co., now completed, and put in operation on Dec. 15, last, is located in Washington, Washington Co., Pa., 31 miles southeast of Pittsburg, and is connected by sidings to the Chartiers Division of the Pennsylvania R. R. and the Pittsburg Division of the Baltimore & Ohio R. R. with excellent switching facilities. The plant is a branch of the old firm of Wm. Jessop & Sons, of Sheffield, England.

The present plant consists of a melting shop, rolling mill, power house and pickling shed. Fig. 1 is reproduced from a recent photograph of the plant. Fig. 2 is a general plan of the works, and Fig. 3 a view in the rolling mill.

The melting shop, 225 × 110 ft., has a structural steel frame, and the roof, sides and floor are covered with concrete and expanded metal with Carey top course for 75% of its length, the remainder being covered with corrugated iron. This building contains three 36 pot regenerating crucible furnaces and 16 scrap shears, with necessary scrap bins. The scrap shears are arranged in two rows, each row having its independent line of shafting and electric motor. A novel feature of the melting shop is that the pouring floor of all furnaces is on the same level, the furnaces being centrally located in the main bay which is 50 ft. wide. On both sides of the main bay are lean-tos 30 ft. wide, with floors on the same level as the pouring floor. This arrangement gives a large floor space with bottoms of scrap bins in one lean-to on this floor and storage room in the other lean-to.

The mold floors are 3 ft. below the pouring floor, and underneath all is a basement 13 ft. high, the floor of this basement being level with the bottom of the furnaces and above high water mark of Chartiers Creek, on the banks of which the plant is located. This basement is used for the manufacture of crucible pots and makes an ideal dry room. Ingots are also stored in this basement, from which they are easily conveyed to the rolling mill by elevators and industrial railways.

The floor level of the shear shop, rolling mill, power house and pickling house are at the same grade, which is 4 ft. below the pouring floor. With the mold floor 1 ft. above shear shop floor and 10 ft. above basement floor, ingots can be easily loaded upon cars from mold floor direct to rolling mill, or carried by chutes to the basement floor. An ingenious chute is used for the latter purpose, whereby the momentum of the ingot in its chute is made to automatically load the ingot upon a movable scale, and when a full heat is thus loaded the scale truck is rolled to topping benches, where the ingots are graded. Pneumatic elevators are plentifully supplied in this department for convenience in handling cut scrap and ingots.

The rolling mill is 270 × 110 ft., with main bay 50 ft. wide and lean-tos 30 ft. wide, of structural steel frame covered with corrugated iron, with the exception of the lean-to over the storage place for finished stock, which is covered with concrete and expanded metal with Carey roof top course. The rolling machinery consists of one 24-in. mill, having three two-high stands of rolls and one pinion stand, direct connected to a Lane & Bodley 28 × 72-in. simple condensing Corliss engine and one 20-in. mill, consisting of four two-high stands of rolls and one pinion stand direct connected to a Lane & Bodley 24 × 60-in. simple condensing Corliss engine. A 10-ton Whiting Foundry Equipment Co.'s electric crane traverses the main bay, having access to all machines handling heavy work. Modern shears, roll lathe and small machinery driven by individual motors are provided for finishing the rolled steel. The screws of the cogging roll housing are operated by electric power, and in fact everything that can be done with electricity to facilitate movement of stock is taken advantage of. Industrial railways cover the rolling mill and the plant in general, and all material is easily handled. Eight heating and annealing furnaces are located in this mill.

Natural gas is used for all heating purposes, and arrangements have been made for use of producer gas if the natural should fail, of which there appears to be little likelihood, as the field from which the natural gas supply is taken appears to be inexhaustible. The gas comes to the plant under a natural pressure of about 60 lbs., and is reduced to 8 oz. The land of the plant is underlaid by the Pittsburg vein of coal at about 300 ft. depth, which may be of use in the future.

The power house is 100 × 60 ft., with brick walls and steel roof trusses, and contains two batteries of Babcock & Wilcox boilers, each consisting of two 270-HP. boilers. The boilers have individual stacks, an economical feature with natural gas. A Wheeler Condenser & Engineering Co.'s admiralty surface-condenser and Barnard water cooling tower are used, with all necessary steam and oil separators, in connection with a Cochrane open heater supplied with exhaust steam from auxiliary feed pumps and air-compressor. A Hall air-compressor of sufficient capacity to actuate all lifting tables in the rolling mill, and elevators in the melting shop and other compressed air apparatus is also installed in the power house. Two 125-HP. Westinghouse gas engines in the power house supply power to two 75-KW. Westinghouse direct current generators, which furnish current at 220 volts for electric crane, for motors, and for lighting.

Water for the plant is supplied from two wells, 200 ft. deep, the pumps for which are electrically driven. These wells are fitted with 3-in. plungers and the economy in use of water through the condensing system and water cooling tower is well demonstrated by the fact that these two wells supply plenty of water. In connection with this it may be stated that the water used in cooling cylinders of gas engines, and air-compressor is returned to the cooling tower, and is more than sufficient (nearly to an even balance) to supply the evaporation of water in the cooling tower. As a matter of fact, since the plant was started, now some three months ago, no water from wells, or other source, has been turned into the cooling tower well except that from the air-compressor and gas engines.

In carefully repeated tests it has been demonstrated that with all conditions the same, the quantity of water used running the rolling mill engines non-condensing is 133° of that used when run condensing. As an auxiliary source of water supply, it was found when excavating for elevators in the melting shop that a large flow of surface water was at hand, and to one of the wells is attached a No. 3 Cameron pump, to be operated by air, if occasion comes up, such as the failure of a deep well pump apparatus. The water supply is carried in a 36,000-gallon tank on a steel tower in the yard.

The starting of the plant for the manufacture of steel and the management of some is in the hands of General Manager J. H. Fisher, who comes from the Sheffield works, of the English concern. Mr. Fisher has grown up with the English firm, and has traveled extensively all over the world in their interests. The present product is the highest grade of crucible sheet steel.

The general contractor for the steel manufacturing portion of the plant and buildings was Jas. J. Mahon, of Pittsburg, Pa. The constructing, designing, erecting of machinery, and all mechanical features of the plant was in the hands of the writer, who remains with the company as Mechanical Engineer.

The architect and contractor for the buildings was Gustave Kaufman, of New York city. The steel structural work in the buildings was erected by the American Bridge Co. The rolling mills were from the Geo. A. Hogg Iron & Steel Foundry Co., who also furnished the large slitting shears and roll lathe. Many of the large shears came from the Vulcan Foundry & Machine Co., and the butterfly scrap shears, of which there are eight, were designed by Mr. Manning from sketches furnished by the Jessop firm, and built by Zahniser Bros. & Sten, of Washington, Pa. This machine is novel in that it has three revolving knives on one head, making three cuts to one revolution of the knife head. Large slitting and long shearing machines were furnished by the Pittsburg Shear Knife & Machine Co. All electrical apparatus was furnished by the Westinghouse Electric & Manufacturing Co. Steam, water, and air pipes were furnished by the Pittsburg Valve Foundry & Construction Co. All grading, excavating, and foundation work was done by C. I. McDonald & Co. of Pittsburg, Pa. The plant has involved an outlay of about half a million dollars.

The officers of the company are Wm. Jessop, President; Sydney J. Robinson, Vice-President; Jas. Jessop, Treasurer; W. F. Wagner, Chairman Executive Committee, and J. H. Fisher, General Manager and Assistant Treasurer; James Warren, Assistant Manager; and F. T. Otley, Secretary. The office of the company in New York city is at 91 John St.

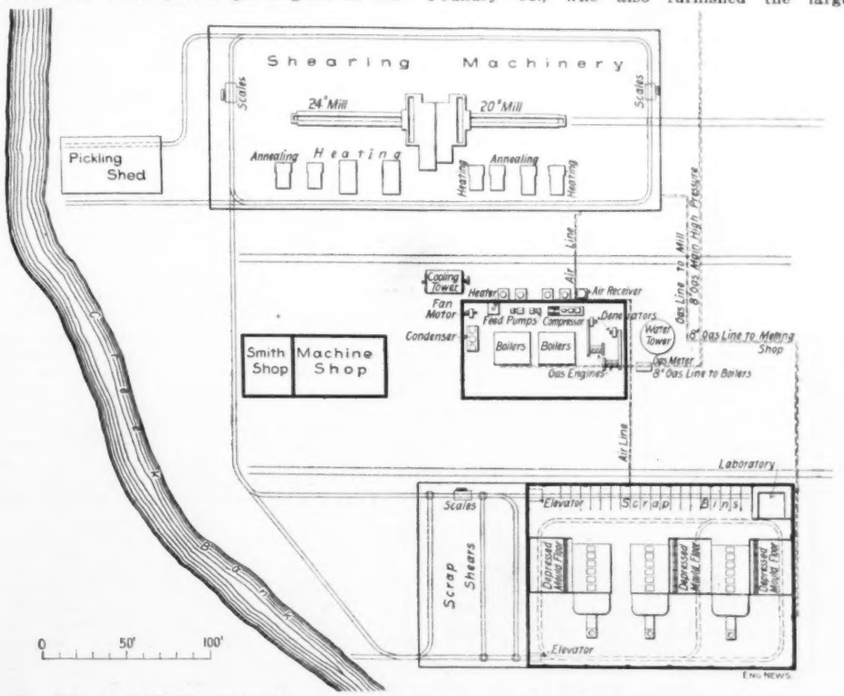


FIG. 2. GENERAL PLAN OF BUILDINGS AND MACHINERY; JESSOP STEEL WORKS.

*Mechanical Engineer, Jessop Steel Co., Washington, Pa.

SOME FEATURES OF THE NEW GARBAGE REDUCTION WORKS AT BUFFALO, N. Y.

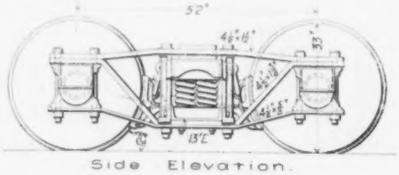
The original garbage reduction works at Buffalo were described at length in our issue of Nov. 1, 1894, and the new plant, rebuilt after a fire, was described in outline in our issue of Dec. 19, 1901. We were unable at the latter date to give any information regarding the new type of dryers, and only mentioned the method employed to treat the gases evolved in the process. There was recently read at Buffalo, before the representatives of the Buffalo Forge Co., a paper by Mr. C. A. Blessing, M. E., of that company, describing some portions of the reduction works, which we have slightly condensed, as follows:

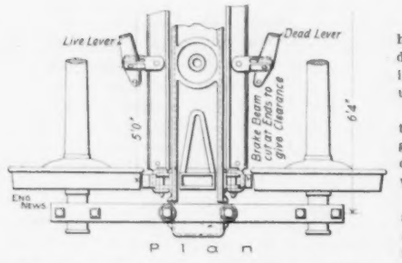
This plant, situated in the eastern portion of the city of Buffalo, is the property of the Baynes Garbage Co.

On entering the works one's attention is at once fixed on what proves to be three large ovens, each of which consists of six revolving cylindrical dryers. These dryers are each 48 ins. in diameter and 13 ft. long, being placed in the oven at a slight slant to the horizontal, and supplied with a separate hard-coal fire with a grate area of 15 sq. ft. The heated gases from the fire are passed around and then through the dryer, by a mechanical contrivance.

On the outside of this building is situated a cooling well, a Buffalo Forge Co.'s exhaust fan direct-connected to an engine of the same make, and the stack. This cooling tower is 7 ft. in diameter and 10 ft. high, plastered with cement, and furnished with a 1½-in. water-pipe spray and a drain to the city sewer. The lead-coated fan is a three-quarter housing top vertical discharge type of the Buffalo Forge Co.'s make, directly driven by a 6 × 8-in. horizontal center crank Buffalo engine. The blast wheel is 78 ins. in diameter, having blades 42 ins. in width, and has a capacity of 24,000 cu. ft. per min. at a speed of 280 revs. per min. The steel stack is 54 ins. in diameter and 80 ft. in height, and is placed upon a heavy brick foundation, which also forms a small furnace directly under the stack. The remaining apparatus consists of four 125-HP. boilers, four Merz grease extractors, two horizontal side crank engines of 75 HP. each, a generating unit with capacity of 150 incandescent lights, and several conveyors, which save much time, labor and expense.

Refuse enters this plant by being dumped from the garbage wagons, which have a capacity of four to five tons each, into a large hopper. It is immediately shoveled upon one of the conveyors and starts up an incline to the second floor. On the second floor it is ground into pieces which contain about 1 cu. in. It is now passed, through the same breeching that conveys the escaping gases to the cooling tower, into the revolving cylindrical dryer, entering at the front or high end of the cylinder. The garbage remains in the dryer for 75 minutes, during which time, as the cylinder slowly revolves and the garbage passes from the front end to the rear, it is not only subjected to the heat of the fire beneath and all around the cylinder, but by an arrangement at the back of the dryer the gases are returned through the cylinder and thus brought into direct contact with the garbage. The gases pass from the back end, where garbage is dryest and requires the greatest heat, to the front, where the garbage has just entered. The refuse is removed from the cylinder at the back and transferred by conveyors to the Merz improved extractors, where the grease is removed by the use of a solvent, and finds ready sale to the trade.





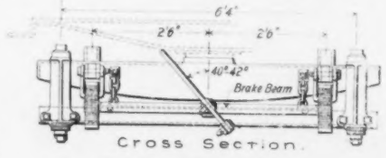


FIG. 2. TRUCK FOR 80,000-LB. GONDOLA CAR, CHICAGO & ALTON RY.

After leaving the extractor, the tankage, as it is now termed, is prepared as a marketable product, by being ground and screened and put in a fine mechanical condition, and is sold to the various fertilizer manufacturers, who use it as a fertilizer base.

Let us now return and follow the course of the gases after leaving the dryer. These gases, which contain acetic, nitric and sulphuric acid gas, the exact composition depending entirely on the nature of the refuse, are sucked through the breeching to the cooling tower, where their temperature is reduced below their dew point, thus depositing a large quantity of the watery vapor and purifying the gas to a considerable extent.

The remaining gases are sucked on into the Buffalo exhaust fans and immediately discharged into the stack. These gases are saturated when they enter the stack, but as they pass over the furnace in the bottom of the stack and mix with the hot gases from this furnace, the dew point of the mixed gas is lowered while the temperature of the gas is increased. The passing of the gas over this fire also destroys any remaining offensive odors that would otherwise escape into the atmosphere.

Although this plant has reduced as much as 175 tons of garbage per day, averaging about 80% of water, or in other words, has handled 140 tons of watery vapor per day, the gases discharged at the top of the stack were odorless and almost invisible.

The conduit for the conveyance of the vapors arising from the dryers, and the exhaust fan, were furnished by the Buffalo Forge Co., of Buffalo, N. Y.

LARGE CAPACITY GONDOLA CARS; CHICAGO & ALTON RY.

Wooden gondola cars of 80,000 lbs. capacity are now being used by the Chicago & Alton Ry. for carrying such freight as coal and gravel, and also for carrying the sand which is used for filling on the company's track elevation work in Chicago. These cars were built by the Georgia Car & Mfg. Co. of Savannah, Ga., and we are indebted to the builders for blue prints of the plans.

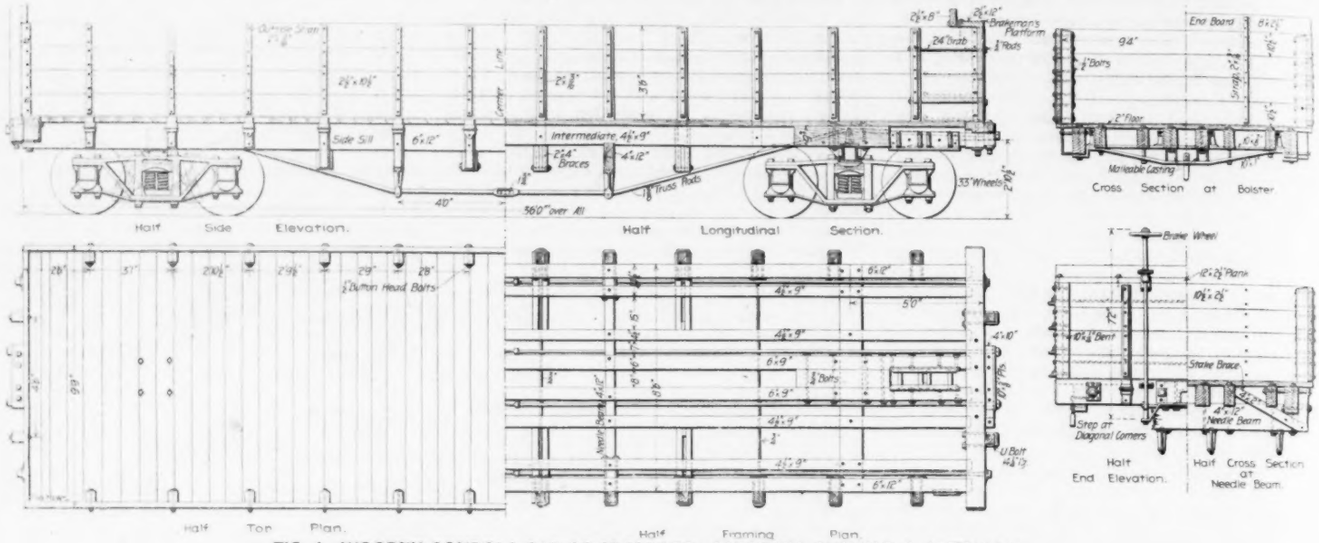


FIG. 1. WOODEN GONDOLA CAR OF 80,000 LBS. CAPACITY, CHICAGO & ALTON RY.
A. L. Humphrey, Superintendent of Motive Power; Georgia Car & Mfg. Co., Savannah, Ga., Builders.

The underframing consists of six longitudinal sills, framed into end sills, and trussed by four 1⅜-in. rods with 1¾-in. upset ends. All the rods extend over saddles above the bolsters and pass through the end sills, while the two middle rods also pass through the dead-blocks. Four transverse ¾-in. rods are run through the sills. The draft rigging is fitted between the center sills, the drawbar passing through the end sills. The side planks are placed outside the stakes, and one of the special features of the design is the transverse trussing to prevent bulging of the sides. Four alternate stakes on each side extend below the sills, and each is braced by a pair of inclined timbers 4 × 2 ins., the upper ends of which are butted against the inner intermediate sills. This bracing prevents any outward tilting of the stakes, due to the pressure of the load. There are no doors. The body bolsters are of steel, having two plates, with malleable iron spacing pieces.

The cars are mounted on trucks with diamond or arch-bar frames, steel channel spring planks and cast steel bolsters. The springs are fitted between wooden blocks on the spring plank and bolster. The brakes are hung inside the wheels.

Fig. 1 shows the construction of the car body and frame, and Fig. 2 that of the trucks. These illustrations clearly show the design and construc-

80,000-lb. Wooden Gondola Car; Chicago & Alton Ry.

	Ft.	Ins.	
Length over end sills	36	0	
Width over side sills	8	6	
Width inside	9	4	
Depth inside	3	6½	
Height to top of floor	3	6⅝	
Height to center of drawbar	2	10½	
Side sills (2)		6	× 12
Intermediate sills (4)		4½	× 9
Center sills (2)		6	× 9
End sills (2)		8	× 11¼
Needle beams (2)		4	× 12
Stakes		4	× 5
Distance c. to c. of trucks	26	0	
Wheelbase, truck	5	2	
Wheelbase, total	31	2	
Wheels, diameter	2	9	
Capacity			80,000 lbs.
Weight, empty			31,00 to 32,000 "

tion, and the principal dimensions and other particulars are given in the preceding page.

In the same class of service the Chicago & Alton Ry. is using a number of steel gondola cars, and Figs. 3 and 4 show an experimental steel car having a trap in the floor through which the contents can be shoveled if required. There are no doors in the sides. The cars are built of plates and structural shapes, the sides and ends being

FIG. 3. STEEL GONDOLA CAR OF 88,000 LBS. CAPACITY, CHICAGO & ALTON RY.
American Car & Foundry Co., Detroit, Mich., Builders.

of plate girder construction. Fig. 3 is a side view showing the gear for operating the door. Fig. 4 is an interior view showing the drop bottom or shallow hopper. This view also shows the cast steel end sill. This car and a number of 100,000-lb. steel gondola cars were built by the steel car department of the American Car & Foundry Co., at Detroit, Mich. Their general dimensions are as follows:

Steel Gondola Cars; Chicago & Alton Ry.

	88,000-lb. car.	100,000-lb. car.
Length over end sills.	39 ft. 0½-in.	43 ft. 0½-in.
Width over side sills..	9 " 3 ins.	9 " 0¾ in.
Length inside	38 " 0 "	42 " 0 in.
Width inside	9 " 3 "	9 " 0¾-in.
Depth inside	3 " 3/16	4 " 0-in.
Height to top of floor	3 " 10 ins.	3 " 9⅞ ins.
Height to c. of draw..	2 " 10¼"	2 " 10¼ "
Side sills, angles	5/16×2½×3 ins.	(2) 3×3½ ins., 7.8 lbs.
Int. sills, channels....	.....	(2) 12-in., 20.5 lbs.
End sills	Cast steel.	¼-in. plate.
Center sills, channels	12-in., 20.5 lbs.	(2) 12-in., 20.5 lbs.
Steel plates, thickness	¼-in.	¼-in.
Stiffeners, angles ...	¼×2½×2½ ins. ¼×2½×3 "	3×2½ ins., 6.6 lbs.
Dist. c. to c., trucks..	28 ft. 6 ins.	30 ft. 8 ins.
Wheelbase, truck	5 " 2 "	5 " 4 "
Wheelbase, total	33 " 8 "	36 " 0 "
Capacity	88,000 lbs.	100,000 lbs.
Capacity, level full...	1,270 cu. ft.	1,522 cu. ft.
Weight, empty.	32,450 lbs.	38,700 lbs.

ALBANY MEETING OF THE AMERICAN INSTITUTE OF MINING ENGINEERS.

The annual meeting of the American Institute of Mining Engineers was held in Albany, N. Y., beginning on Tuesday evening, Feb. 17. It was a highly successful and enjoyable meeting, but the attendance was rather small, only 93 members having registered by Thursday morning. This is less than 3% of the membership of the Institute, which is now over 3,400. Great preparations were made by the Albanians for the entertainment of the members and their wives. A local committee of about 150 citizens of Albany and Schenectady was appointed; all the clubs of the city issued cards of invitation to the visitors; the rooms of the Albany Institute and Historical and Art Society were secured for the meeting; free carriages, set on sleigh runners as is the winter custom in Albany, were provided to convey the members and guests from the hotel to the meeting and back; and receptions, excursions, lunches, etc., were tendered through the whole week, including Saturday.

The headquarters were at the Ten Eyck, one of the finest hotels in the state, where everything possible was done to make the visitors comfortable. The weather was clear and dry throughout the week, with the thermometer in the neighborhood of zero each morning, but no one seemed to suffer on account of the cold. The technical sessions were of little importance from a professional standpoint, as most of the long list of papers were presented as "read by title" only, and those that were given in full were chiefly popular lectures illustrated with lantern slides, but these latter were excellent and were greatly enjoyed. The principal features of the meeting were the excursions, the banquet, and the meeting of old friends, which are always the best parts of a mining engineers' meeting.

The first session was held on Tuesday evening. It was opened with an address of welcome by Mayor Gaus, of Albany, which was responded to by President Olcott. Acting Secretary Dwight then read a minute adopted by the council in reference to the death of the former president of the Institute, Hon. Abram S. Hewitt. Later in the evening the president-elect, Dr. Albert R. Ledoux, read a tribute to Mr. Hewitt, which had been prepared by the secretary, Dr. R. W. Raymond, while in Rome, where he is now taking a vacation.

Mr. Howard DuBois, of Philadelphia, then gave a lecture describing an exploring tour in British Columbia, illustrated with a great number of splendid lantern views showing the scenery in the Rocky Mountains, and the difficulties met with by the expedition, which had to swim deep rivers, cut its way through dense forests, etc.

Wednesday was devoted to an excursion to Schenectady by trolley cars. The works of the General Electric Co. were visited in the morning, and after lunch provided by that company about two hours were spent in the works of the American Locomotive Co. The time was too short to allow of more than a rapid walk through the principal shops of the vast plant of the General Electric Co., but enough was seen to give the visitors a good idea of the works and of the splendid or-

Fig. 4. Interior View of Steel Gondola Car, Chicago & Alton Ry.

ganization. There are now 10,000 men employed, and this number will soon be increased, as some new buildings are being erected. The Curtis steam turbine was one of the most interesting things seen in operation. It has been running about a year, and is said to have demonstrated its equality in steam economy with the best compound engines. The company is not yet advertising it for sale, but has already received orders for as many as can be turned out in the next year. The new machine shop, in which the pieces to be operated on are bolted down to a heavy floor plate which covers the greater part of the shop, and the machine tools are carried by overhead cranes to the work, was greatly admired by the visitors. For such large pieces as the frames of large alternators the new system offers many advantages.

The Schenectady locomotive works, which are the largest works in the consolidation known as the American Locomotive Works, and are surpassed only by the Baldwin works in Philadelphia, were next visited. Many improvements are in progress, including the erection of two large buildings. The works employ 4,500 men and have a capacity of 600 locomotives per year.

There was nothing on the programme for the evening, but many of the members attended a lecture on wireless telegraphy by Mr. John F. McElroy, at the Aurania Club.

On Thursday morning the members were received in the capitol by Governor Odell. Short addresses were made by the Governor and by President Olcott. The Governor addressed the members as "brother engineers" because he said he had attended the School of Mines in Columbia College, although he did not get the certificate of graduation from that school. A marriage certificate came in and superseded it. Introductions of the members and handshaking then took place. The reception was followed by a tour through the capitol building under the direction of members of the local committee. Both houses of the legislature were in session. The library of the Regents of the University, the unique educational establishment of the State of New York, which has supervisory authority over other institutions, but has no teaching force, no students, and no building, was found especially interesting on account of the important old historical documents which it contains.

In the afternoon a session was held in the lecture room of the Historical Society. It was devoted to papers on electricity in mining. The first was an illustrated lecture by Mr. F. O. Blackwell of Schenectady, showing views of various electrical installations and apparatus for use in mines. As the paper was not printed in advance no one cared to discuss it. It was followed by a paper on "The Present Electrical Equipment of the Anthracite Field," by H. H. Stoek and G. W. Harris, Scranton, Pa. It was read from manuscript, not having been printed in advance of the meeting, and it was not discussed. The next paper was by Mr. W. B. Clarke, of Schenectady, on "Electrical Apparatus for Coal Mining." The apparatus described consisted first of a "gathering" locomotive for use between the breasts and the main entries, in which a flexible cable conveying the current is wound on or off a reel on the locomotive as it travels, and, second, a double current generator recently installed by the Webster Coal and Coke Co., Ehrenfeld, Pa. A belt driven generator delivers direct current at 275 volts from one side to the haulage system, and three-phase alternating current at 165 volts from the other side. The latter is raised to 5,600 volts by step-up transformers and carried 9,000 ft. to a substation in the mine, where by means of static transformers and a rotary converter a direct current of 275 volts is delivered to the haulage circuits.

Mr. Clarke's paper was printed in advance in the shape of an "uncorrected preliminary proof," and it contained some statements antagonistic to the use of compressed air in mines except for the operation of rock-drills and coal "punchers." "The conditions in many mines," he says, "prohibit the undercutting of coal with a chain machine, and the compressed-air 'puncher' with its very low efficiency is extensively employed." Several other statements reflecting unfavorably upon compressed air were contained in the paper. Mr. W. L. Saunders, of the Ingersoll-Sergeant Rock Drill Co., was present at the reading of the paper, but was called out on business. The next day he was asked to discuss the paper, and he did it in a most vigorous fashion. He said his company is now building a new plant, costing $1,250,000, to meet the increasing demand for air compressors for mines, and while giving full credit to electricity for the work of bringing power to the mine from a distance, he holds that for all

operations underground compressed air is supreme. The debate was a one-sided one, for Mr. Clarke was not present on Friday to defend his paper, and none of the electrical engineers present seemed to care to enter the lists with Mr. Saunders.

On Thursday evening a banquet was held in the Ten Eyck Hotel. Over a hundred persons were present, about a third of them being ladies. The speeches were few in number, but were unusually fine, as Albany furnished three of her best after-dinner speakers, viz.: Rev. Walton W. Battershall, D.D., Mr. Lewis E. Carr, and Mr. Danforth E. Ainsworth. Capt. Robert W. Hunt, a Past President of the Institute, was toastmaster, and speeches were also made by the retiring president, Mr. E. E. Olcott, and the president-elect, Dr. A. R. Ledoux. The "Order of Cross Hammers" was conferred upon the latter as part of the fun of the evening. The sign of the order was a gilded badge the size of a dinner plate, with the engineers' hammers, and the letters A. I. M. E. enameled on it, and suspended by a heavy gilded trace chain.

On Friday morning another session was held, at which Mr. Saunders spoke as above mentioned, and two papers were read by Mr. R. V. Norris, of Wilkesbarre, Pa., on "The Cost of Pumping at the Short Mountain Colliery of the Lykens Valley Co." and on "Water-Hoisting in the Pennsylvania Anthracite Region." We shall give abstracts of these papers later. Papers were also read by Mr. Anson G. Betts of Troy, N. Y., on "Refining Lead by Electrolysis," and by Dr. A. R. Ledoux, on "Accidents Due to Combustion Within Air Compressors." Mr. Verplanck Colvin exhibited the original compass made of wood with brass fittings, which were used by the Colonial Surveyors of New York in 1752. It is a very crude instrument, and it explains the inaccuracy of the early surveys in New York State.

A long list of papers was presented as being "read by title." A very few of these are now in printed form for distribution, others are in manuscript, while still others are only "announced," and will appear some day in the printed volume. This method of presenting papers is an ancient one which has been abandoned long ago by other societies, and it ought to be abandoned by the Mining Engineers. To it is chiefly due the fact that the meetings of the Institute are attended by such a small fraction of the members, and that the discussions of the papers are so unimportant.

Among the papers in print there is a "Note on the Influence of the Rate of Cooling in the Structure of Steel," by Albert Sauveur and H. C. Boynton, Cambridge, Mass. Two samples from the same bar were heated to 1,000° C. (1,832° F), one was cooled in air and the other cooled with the furnace. Under the microscope the air cooled sample showed a sharply defined net work structure, while the furnace cooled piece showed a granular structure. Many similar experiments showed identical results. It was found that the air cooled specimens showed the higher strength and elastic limit, and the lower ductility. Following are some of the results.

Treatment of sample.	Heated to 1150° C. and cooled	
	With furnace.	In air.
Character of dark constituent	Pearlite.	Sorbite.
Elastic limit, lbs. per sq. in.	39,901	53,260
Tensile strength, lbs. per sq. in.	81,162	99,979
Elongation, in 8 ins.	17%	12%
Reduction of area	27.61%	20.55%

The paper also discusses pearlite, sorbite, ferrite, martensite, eutectic alloys, etc., which are of interest to the student of the micro-structure of steel.

In he afternoon a trip was made by trolley cars to the U. S. Arsenal at Watervliet. The large gun factory only was visited, where was seen the operation of shrinking a jacket on a 6-in. gun. The massive machinery for manufacturing seacoast guns up to 16-in. caliber was examined with great interest.

The final session was held on Friday evening. It was chiefly devoted to an illustrated description of the method of constructing the great dam at Spier Falls on the Hudson, 9 miles from Glens Falls, which the engineers were invited to visit the next day. The dam has been under construction for three years, and is now about completed. It will furnish water for 20,000 HP. as a minimum, at low water, and 50,000 HP. for the greater part of the year. The dam is 1,570 ft. in length, 157 ft. high at the lowest point, 115 ft. broad at the base, and 22 ft. thick at a point 8 ft. below its rounded top.

Unusual difficulties were met with in constructing the dam. Coffer dams built out from the banks were swept away by floods and excavations for the base of the dam were filled with boulders and other flood debris. Many excellent lantern slides shown by the lecturer gave a clear idea of the method of constructing the dam and of the troubles met and conquered. The Hudson River Water Power Co., which owns the Spier Falls plant and others in the vicinity, has already contracted to supply over 35,000 HP. to the General Electric Co., the Glens Falls Portland Cement Co. and traction and lighting companies in Albany, Troy, Saratoga, and other places, and claims to have an annual income already assured of more than $1,400,000 from its several properties. The prices charged for current are evidently based on "what the market will bear" and range from a minimum of $22.50 per HP. to the General Electric Co. to $63.40 per HP. for power and $60 per HP. for light to the lighting companies of Troy and Albany.

A lantern exhibit was made by Capt. W. H. Jaques of some solar motors which he has recently erected in Arizona. The reflectors are 36 ft. diameter, and contain 10,000 sq. ft. of surface. The motor is a small steam boiler which receives the concentrated rays of the sun and a condensing steam engine. The motor is 10 HP. and is used to pump water on an ostrich farm, and is said to be an entirely practical machine. It costs about $3,000. For irrigating the arid regions it seems likely to be better than windmills, and cheaper than any motor that requires fuel to run it.

On Saturday a choice of two excursions was offered. The first was to the works of the Helderberg Cement Co. at Howe's cave. The party was a small one, but it was well entertained by a trip in the cave and through the quarries, mines and cement works, which are said to be the finest in the country. The yearly capacity of the plant is over 600,000 barrels. It is operated by electric power furnished by the Empire State Power Co. from a dam 18 miles distant in Schoharie County. Luncheon was served at the works, and the party returned to Albany at 5 p. m.

The second party, which went to Spier Falls, was larger, numbering 48 of the members, with additions from local committees and parties financially interested in the Hudson River Water Power Co., bringing the total number up to about 100. The special train left Albany at 9 a. m. and reached Glens Falls at 11.15, where sleighs were in waiting to convey the party to Spier Falls, 9 miles distant. Fur overcoats, of coon or bear skin, were provided for each of the guests, but the weather had moderated to such an extent that they were scarcely needed. On arrival at the Falls luncheon was served at the company's hotel, and then the dam, the quarries, the hoisting and conveying plant, power house, etc., were inspected. The power house will contain ten turbines, each of 5,000 HP., running under 90-ft. head. The dam will contain 181,000 cu. yds. of masonry. Work is now progressing on it with great rapidity, no less than seven cable conveyors being in constant operation, carrying cut stone and concrete. The stone is laid whenever the temperature rises about 20° F. Late in the afternoon the party returned to Glens Falls, where a dinner was given in the Rockwell House. Speeches were made by Mr. E. H. Gay, treasurer of the water power company, and by Mr. Olcott, president of the Institute. There was a long delay at Glens Falls on account of some trouble with the special train, and Albany was not reached until 1.15 a. m., or three hours behind the schedule time.

An interesting piece of statistics of attendance at an engineering society's convention is obtained from the experience of Mr. Dwight, the acting secretary of the Institute. During January he sent out notices of the meeting with a reply postal card, on which each member was asked to state whether he would probably attend the meeting. The number of affirmative replies by members was 139, not including ladies. Arrangements for excursions, banquet, etc., were made upon this basis, and on Jan. 28 a final circular announcing the meeting was issued, and it contained the names of these 139 members who had already expressed their intention of attending the meeting. A very few of these wrote later saying that they would be unable to attend, but only 28 out of the 139 actually appeared at the meeting, and of the 93 members registered as being in attendance, 65 had not previously intimated that they were coming. The sudden severe snow storm and gale and the intensely cold weather just preceding the meeting may have been the cause of the non-attendance of many of those who were expected, but many must simply have forgotten to notify the secretary they were not coming, so as to help him make his arrangements.

The following officers of the Institute were elected at the Albany meeting: President, A. R. Ledoux, of New York city; Vice-President, John Markle, Jeddo, Pa.; Philip W. Moen, Worcester, Mass.; James F. Kemp, New York city; Managers, Heinrich Ries, Ithaca, N. Y.; B. B. Lawrence, New York city; F. Klepetko, Butte, Mont.; Treasurer, Theodore D. Rand; Secretary, Rossiter W. Raymond.

The next meeting of the Institute is to be held in British Columbia. A special train will leave Montreal, on the Canadian Pacific Railway, about the middle of July, and after the meeting in Vancouver an excursion by steamer and rail will be made to Alaska, including the Klondike region. The whole trip, including the return by the same route to Montreal, will take nearly six weeks. A circular announcing this trip will soon be issued.

A NEW ROCK DRILL has been recently introduced into the South African gold mines. It is the "Water Leyner Rock Drill," and is provided with a pump for forcing water up through a small hole in the core of the drill, so as to wash out the chips and dust. It is spoken of very highly especially for use in holes that "look up," that is holes that are ordinarily drilled dry, as a consequence creating much dust in soft rock unless some such device as this is employed.

THE LIFE OF CREOSOTED TELEGRAPH POLES.*

By A. T. Kinsey.

Timber is used for poles in preference to iron or steel, chiefly on account of its lower cost, which may be one-third of that of iron. Some means of preparation of the timber so as to render it capable of resisting the attacks of dry and wet rot are, however, necessary; various treatments have been tried and abandoned, creosoting being the only method of any practical value and the only one much in use to-day.

One of the best timbers for poles is Norway red fir, but any timber that is used must be thoroughly seasoned and dried before treatment. The quantity of the preservative injected is 8 lbs. per cubic foot. It does not penetrate to the heart of the pole, but when the timber is very dense an inch or two inwards only. There is an unprotected portion—viz., the heart and the interior margin of the zone through which the creosote penetrates. It is in this unprotected zone that dry rot usually sets in, taking the creosoted zone and leaving the heart more or less intact, with the outside skin of the pole unbroken or marked. But dry rot is comparatively rare. It is found that in the course of time the creosote sinks from the top to the butt of the pole, forming a thick crust on the surface of the latter, where it is most needed as a protection against wet rot which attacks from without and proceeds inwards.

In 1880, in England the life of treated poles was found to be 30 years. Poles taken down in that year which had been planted in 1849 and 1850 were found to be in all respects as sound as when erected. Since that date creosote had deteriorated in quality owing to the increased value of some of its constituents, and the author thought it time to investigate the matter again. He traced the erection of creosoted poles in Ireland as early as 1858, and again in 1860-1, but the systematic branding of the date of creosoting upon the poles with a hot iron was not begun by the department until 1873, and it is, therefore, impossible to identify with certainty poles creosoted before that date. As a result of examination by percussion of the poles thus branded, at the butt and 24 ft. up, he is able to state that they are still apparently quite as sound as when first erected; and there is an unbroken series of poles branded from 1873 to the present year.

*Abstract of a paper read before the Dublin section of the Institution of Electrical Engineers (London).